THE

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THE

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NIAGARA FALLS ELECTRICITY WORKS.

THE discussion on Prof. Forbes's paper on this subject has now closed, but we are not much wiser in regard to the scientific principles called in question; too often many of the speakers wandered from the main question altogether, and discussed the scheme from a general point of view, instead of its aspects as a power distribution plant. In the paper Prof. Forbes made it quite clear that power distribution was the object in view, electric lighting being quite a secondary consideration; that being so, many of the remarks made were wide of the mark.

The discussion was one of the most peculiar kind. The methods pursued by the Cataract Construction Company during the initial stages of their proceedings, and their subsequent conduct, were vigorously denounced; but Prof. Forbes, in his explanation, justified the position held by himself, stating that as his designs and system had been adopted, the Cataract Construction Company, or "International Commission," had given him the superintendence of the work in fulfilment of its promise to give the appointment to the engineer whose plans were accepted. The only remarks we care to make on this part of the subject are that, engineers who make dynamo designing, construction, and working, their daily occupation, should never enter into competition for work which professors may be called upon to do. The Cataract Construction Company could not adopt any dynamo machines such as are commonly employed in the comparatively small plants used elsewhere, and were compelled to obtain the most complete information on the subject of designing large dynamos. They proceeded to obtain their knowledge by an arrangement characterised by Mr. Ferranti as one which had been beautifully worked, and into which everybody had fallen. Having obtained the most complete ideas and plans regarding large dynamo-designing held by many men who have made it their business to devise and construct dynamos, they adopted Prof. Forbes's scheme, which he claims to have put before the so-called "International Commission." This, in his own words, given in his reply to his critics, was:—"To use alternating currents of two phases, 2,000 volts pressure for near-by work, step-up transformers for distant work, synchronous motors, Tesla motors, laminated field motors, and commutators." This is doubtless a skeleton outline of the scheme detailed in his paper, but in it there was no design for the alternators, so that evidently a mere outline scheme for the great work was all that was required to secure the appointment which tempted some engineers to send in full plans and details. There they made the mistake and fell into the arrangement.

A competition such as took place in the Niagara Falls Electricity Works ought to have been confined exclusively to engineers who had already constructed, designed, and operated, many large plants. In other large engineering undertakings

the designs, the superintendence and carrying out of the work, are entrusted only to men of long experience in the actual work. Take, for instance, a steamship; would any company ever think of taking into serious consideration the plans of a professor for a ship about to be built? Never. A few first-class shipbuilders would be invited to submit plans, drawn up by experienced men who had perhaps a score of ships afloat to point to as examples. We thoroughly agree with Mr. Ferranti in the following remarks made by him on this point:—"There was, he thought, a very great difference, which might not appear at first sight, between designing dynamos and building them as a regular practice; in fact, between a thing which one made one's ordinary daily business, and getting together a collection of all the information which was available in the world, and this in no limited sense, and then, without any previous knowledge of dynamo design, and especially building, and more especially running, to design a machine which is supposed to fulfil great expectations. If the designs of any one of the many constructors had been taken, if it had been left to those who made the best designs to design finally and build the dynamos, instead of contemplating the idea of designing a machine for them, it would, he thought, be a more satisfactory way, and more certain of success."

Prof. Fleming congratulated the Cataract Construction Company on securing engineers willing to travel over Europe and cull the experience and knowledge of the world for their special benefit. This proceeding Prof. Fleming considers much more difficult work, and preferable to working out plans of their own, and he says it would have been much easier to sit down and design something very original. We are not so sure about that, most people would prefer the travelling. At any rate, it does not require great experience or practice in drawing offices and workshops to qualify one for Continental travel, while it requires years of experience to qualify one to sit down and design a great electrical engineering scheme, and afterwards carry it through. Prof. Fleming related some things observed by himself in his travels in pursuit of useful knowledge; especially how he had seen alternators running in parallel, and being coupled on or uncoupled from the mains by the aid of artificial loads, such as Prof. Forbes proposed in his paper. This performance he had been shown by a brother professor. Now, artificial loading, as was pointed out by Mr. Mordey, is a method now obsolete; no practical engineer at this date would ever think of employing such a clumsy device. There are several other plans in daily use far better than artificial loads.

Then again, the Professor made much of the methods devised by them, assisted by some engineers, who, of course, only *assisted* in carrying out the scheme for switching off and on the mains and feeders. These methods are as antiquated as the artificial load, and were first called into requisition in the early experiments of Marcel Deprez, on long distance transmission of power. No electrical engineer worthy of the name requires to consult a professor on the questions of switching high-pressure mains and preventing surging due to induction; these questions are thoroughly well known to engineers, and their solution is quite an easy matter.

Mr. Mordey did not approve of the low frequency, nor did any of the speakers who touched on that point. The cost of transformers, as given by Prof. Forbes for different frequency, was not accepted. Low frequency was clearly shown to have no advantages whatever over high frequency; at any rate, none over frequencies of 60 to 100 ~ per second. It is just as easy, and far cheaper, to make alternating current appliances for these common frequencies than for 25 ~ per second. Of course, we know the low frequency has been adopted with an eye to motors only, but Mr. Kapp fairly knocked the bottom out of the arguments used to justify low frequency being adopted for motor purposes, and, by using the professor's own figures, actually showed that what had been calculated to be a loss of 42 per cent. against high frequency, was, in reality, a gain of 33 per cent. in favour of it for motors.

Low frequency does not enable a synchronising motor to be easily or cheaply made and started, nor does it in any way whatever affect the parallel working of alternators, favourably or otherwise. The remarks of Prof. Fleming on the frequency question are not calculated to make it any clearer why low frequency should be adopted. There can be no likeness between frequency and rate of progress, as drawn by Prof. Fleming; there is no parallel in the questions "what is the best frequency?" and "what is the best rate to walk at?" The rate of progress may depend on what you want to do, and where you want to go; but frequency does not; the only arguments which have any weight in favour of low frequency are, the reduction of resonance, Hughes's effects, and capacity; these effects are great favourites with professors, but with practical engineers they have become very common place subjects; their importance has been very much magnified, and the difficulties in dealing with them are altogether imaginary.

Neither for transforming, nor for motors, nor for parallel working of alternators, has low frequency been shown to offer the slightest advantage. We know most certainly that Prof. Forbes is mistaken in saying that "while his (Mordey's) alternator worked nicely in parallel, it did not work perfectly." Some tests referred to by us in the ELECTRICAL REVIEW of July 17th, 1891, made at Messrs. Willans and Robinson's, proved beyond all cavil that these alternators work perfectly in parallel. If they did not work perfectly, we would have no hesitation in saying now that no alternators could work perfectly in parallel, not even those designed for Niagara Falls works. The fact is, all alternators designed by experienced men work equally well in parallel, and Prof. Forbes did not show wherein his design was an improvement, as regards the obtaining of more perfect parallel running, except by his claim that low frequency improved the running in parallel. None of the critics admit this claim; we ourselves believe low frequency introduces a difficulty by prolongation of the dead points in motors, and that alternators run equally well in parallel at all the ordinary frequencies in use.

There is a "best frequency;" we believe it to be about 60 per second, and electricians must sooner or later adopt that as one uniform frequency. The existence of different frequencies is, in many ways, a hindrance to progress, and introduces needless expenses in manufacturing such things as arc lamps, transformers, rectifiers, and motors, for different frequencies. It is surprising to us that this most important point should be passed over at such a discussion. It does not matter where the current is going, or what is to be

done by it; there is a frequency which suits equally well for all cases; at a frequency of 60 there is no trouble whatever with "parallel running" or with motors, and the resonance, capacity, and "Hughes effects" are just as easily dealt with at that frequency as at any other frequency, while with lower frequencies the transformers become expensive and less economical, and electric lighting becomes unsatisfactory.

The question of pressure, we think, will be settled in practice easily; having got an alternating current, the pressures can be varied to anything wanted by transforming.

We believe the step-up transformer is becoming the proper apparatus for high-pressure working. At Deptford we believe it is gradually being more and more used in place of direct generating at high pressure, low pressure alternators being used in preference to those running at high pressure.

Mr. Ferranti referred to the patents question, as we ourselves did in our previous article on this subject. Although the company may have steered clear of patentees' claims on the dynamo design adopted, they are not likely to escape from the claims existing upon almost every detail of a multiphase system. A powerful effort is to be made in America to secure a monopoly by means of patents in the manufacture and supply of two-phase apparatus; these difficulties shall occupy fully the energies of this "most powerful of New York capitalists" in establishing their business.

The Niagara Works are only of interest from their magnitude as a water-power plant. Nowhere in the world is there such an enormous amount of power to draw upon, situated in the midst of great natural facilities for manufacture and transport. This plant under discussion is only a beginning, and may answer a purpose for a time, and, no doubt, undergo many radical changes before it is found satisfactory in practice. It is impossible to foresee everything in a new scheme, but we hope Prof. Forbes's confidence in its turning out a perfect success will be fully confirmed after the wheels begin to go round at Niagara.

The "Flashing" Suit in America.

EARLY this year we incidentally referred to Mr. Weston's somewhat remarkable claim to be the first inventor of this process as applied to incandescent lamp manufacture. We now learn from the *Electrical World* that Mr. Weston's patent, which was applied for on May 20th, 1881, and granted October 21st, 1884, has been held by the Court of Appeals in New York to be nul and void, by reason of anticipations. This news is not surprising, but it would have been interesting if a few of the arguments depended upon in the Weston case had been cited, for Maxim, Lane-Fox, to say nothing of Sawyer and Man, had used the process commercially prior to the application of the patent in question. It is of interest to remark that one of the main reasons for employing this beautiful process in early days, and one which is still frequently advanced by those who are not *au courant* with the subject, viz., that of healing up the spots and bright parts in the foundation filament, is now practically obsolete. As a matter of fact, there are probably few lamp factories in existence where the "baked" filaments do not light up perfectly uniformly throughout their length, owing to the absolute uniformity of their sectional area and resistance. One very significant reason for continuing the use of the process, which is little known outside the lamp factory, is that the time required to remove the occluded gases during the operation of exhaustion of the lamps is very much less when the filaments have been "flashed." It would be economical to use the process in lamp manufacture for this sole object, let alone the convenience of making lamps of different candle-power and resistance, the increased hardness and elasticity of the carbon, and other valuable features which result from its use.

The Duration of a Discharge Flash.

IN some recent photometric experiments carried out by A. M. Mayer, and which led to the production of a new photometer, some interesting observations were made on the duration of the flash of a discharge from a Holtz induction machine. He estimated that with a striking distance of 8 cm. the duration of a single flash was less than the one-millionth part of a second. The condensing surfaces on the two Leyden jars connected with the electrodes of the induction machine used in their experiments, equalled 135 square cms. Prof. O. N. Rood measured the duration of the flash of Leyden jars of 738 and 71 square cms, of surface charged by an inductorium, and found them respectively to be $\frac{1}{3700000}$th second and $\frac{1}{9500000}$th, from which results Mayer infers that the duration of the flash of the Holtz machine did not exceed $\frac{1}{10000000}$th second. With shorter striking distances between the electrodes the flash is formed of several separated acts, as shown by Henry, Feddersen, Rood, and Mayer. In the case of the discharge of a large inductorium the last named observer has shown that when the striking distance between the brass ball electrodes is only 1 millimetre, with a Leyden jar of 242 square cms. of surface in circuit, the discharge lasts $\frac{1}{34}$th of a second, and is formed of over 720 separate sparks, but, as the striking distance is increased, the discharge is formed of fewer and fewer components, till, at a striking distance of between 1 and 2 cms., the discharge is reduced to a single flash.

Low Frequency Currents.

THE *Electrical World* of the 2nd inst. contains an article by Lieut. F. Jarvis Patten, wherein is described an ingenious method he has devised for obtaining currents of very low frequency. The apparatus is evolved from the old-fashioned and simple liquid rheostat, and is called the "liquid commutator." It consists of "a circular tub, provided with two conducting terminals or electrodes secured to the outer walls of the trough at the opposite extremities of a diameter, and these electrodes are connected to the two mains of a source of direct current (an independent R controlling the supply). A vertical spindle at the centre of the trough carries a revolving arm provided with conducting plates or electrodes at its extremities. These plates are insulated from each other, and are connected each to a ring contact carried by the spindle, on which bear brushes, to which the circuit for the desired alternating current is connected." It is clear that no great rate of speed of rotation can be practicable by this arrangement, but for slow speeds and consequent low frequency it has much to recommend it. Multiphase currents can also easily be obtained from it by an adaptation of contacts and connections which need not be further described. Lieut. Patten does not profess to have found any special use for these low frequency currents, except, curiously enough, a physiological one. He states that, as such currents are practically sinusoidal, and the apparatus is devoid of self-induction, they are exceedingly pleasant to the sensation. From this he argues that they are likely to have considerable therapeutic value, apparently forgetting that the therapeutic value of electric currents depends but very little on their effects upon sensation only. Electrolytic and cataphoric effects are manifestly best obtained from direct currents, while muscle and nerve stimulation can only be produced by more or less sudden changes of potential, to which these low frequency sinusoidal currents can scarcely lay claim. Indeed, their very pleasantness shows that they do not possess this power. It is not easy, therefore, to see in what way currents of this order can have any special therapeutic value. We do not say it is impossible, but it hardly seems reasonable. There seems too much tendency just now, in matters electro-therapeutic, to emulate the Athenians of old, and run after "some new thing," without rhyme or reason. The article goes on to show how the same device may be applied to use as a motor for special purposes. The application is ingenious, and, we believe, novel. One advantage claimed is the entire absence of sparking. The whole scheme is entirely simple in construction, and opens up a field well worth further investigation, in which the varying insulating properties of different fluids would probably play no inconsiderable part.

THE TESLA OSCILLATOR.

THIS apparatus, exhibited by Tesla at the World's Fair, Chicago, attracted some attention. From a description in the *Electrical Engineer*, of New York, we take a sectional view, fig. 1, of the apparatus, and our readers may gather some notion of its construction from that and the description.

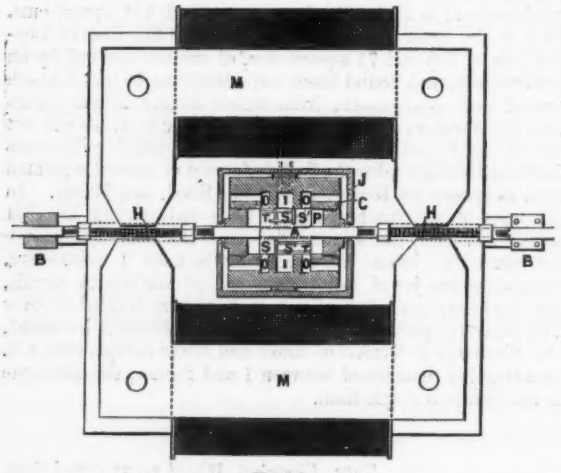


FIG. 1.

Just what this apparatus accomplishes is not made clear; no figures are given upon which one could calculate. It seems to be a kind of alternator designed to give very high frequency by imparting a rapid to and fro motion to two pairs of coils in a very strong magnetic field. The greatest frequency thus obtained is not stated, so that we are unable to compare it with rotary alternators; in that respect it would be interesting to compare it with Prof. Ewing's oscillator or alternator for high frequency, consisting of a Parsons steam turbine and a multipolar alternator.

In the sectional view a piston, P, is seen fitted into the hollow of a cylinder, C, which is provided with channel posts, O, O, and I, extending all round the inside surface. In this particular apparatus there are two channels, O, O, for the outlet of the steam or air used to drive the piston to and fro; I, being the inlet for the air or steam. The piston, P, is provided with two slots, S, S′, at a carefully determined distance, one from the other. The tubes, T, T, which are screwed into the holes drilled into the piston, establish communication between the slots, S, S′, and chambers on each side of the piston, each of these chambers connecting with the slot which is remote from it. The piston, P, is screwed tightly on a shaft, A, which passes through fitting boxes at the end of the cylinder, C. The boxes project to a carefully determined distance into the hollow of the cylinder, C, thus determining the length of the stroke. Surrounding the whole is a jacket, J, to deaden the sound produced by the action of the oscillator.

A magnetic frame, M, M, is fastened so as to closely surround the oscillator and is provided with energising coils which establish two strong magnetic fields on opposite sides. The magnetic frame is made up of thin sheet iron. In the intensely concentrated field thus produced, there are arranged two pairs of coils, H, H, supported in metallic frames which are screwed on the shaft, A, of the piston and have additional bearings in the boxes, B, B, on each side. The whole is mounted on a metallic base resting on two wooden blocks.

The operation of the device is as follows: The working fluid being admitted through an inlet pipe to the slot, I, and the piston being supposed to be in the position indicated, it is sufficient, though not necessary, to give a gentle tap on one of the shaft ends protruding from the boxes, B. Assuming that the motion imparted be such as to move the piston to the left (when looking at the diagram), then the air rushes through the slot, S′, and tube, T, into the chamber to the left. The pressure now drives the piston towards the right and, owing to its inertia, it overshoots the position of equilibrium and allows the air to rush through the slot, S, and tube, T, into the chamber to the right, while the communication to the left hand chamber is cut off, the air of the latter chamber escaping through the outlet, O, on the left. On the return stroke a similar operation takes place on the right hand side. The oscillation is maintained continuously and the apparatus performs vibrations from a scarcely perceptible quiver amounting to no more than $\frac{1}{64}$th of an inch, to vibrations of a little over $\frac{3}{8}$ths of an inch, according to the air pressure and load. It is, indeed, interesting to see how an incandescent lamp is kept burning with the apparatus showing a scarcely perceptible quiver.

The piston cushions against the enclosed air in the cylinder so that even at high velocities it is stopped and reversed without shock. As an apparatus for experimental research on high frequency alternating currents this alternator or oscillator may have the advantages claimed for it, but it does not possess any recommendations as a practical alternator.

As to the novelty of the air or steam oscillator for producing the rapid to and fro motions there is none; a common stone-cutting or engraving tool has long been in use in which this very same idea has been worked out in a thoroughly efficient manner, a piston and cylinder working a small chisel to and fro at a speed of 20,000 per minute by means of compressed air.

THE IMPEDANCE OF MUTUALLY INDUCTIVE CIRCUITS CONTAINING CAPACITIES.

BY E. C. RIMINGTON.

(*Concluded from page* 666.)

It will be more easily understood if we draw the E.M.F. diagram for this case, as in fig. 1. Since $p\,\mathrm{L} - \frac{1}{p\,\mathrm{K}_1}$ is negative, we must draw $\mathrm{O\,B} = \left(p\,\mathrm{L} - \frac{1}{p\,\mathrm{K}_1}\right)\mathrm{C}_1$ downwards and at right angles to O A, which equals $\mathrm{C}_1 r_1$, as before.

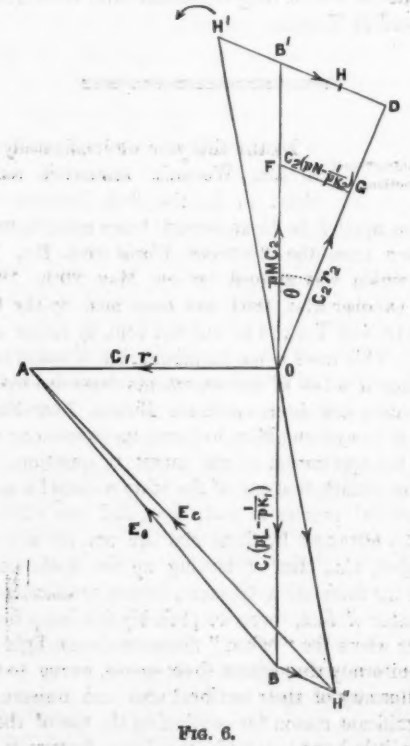


FIG. 6.

Now, $\mathrm{O\,F} = p\,\mathrm{M}\,\mathrm{C}_1 = \mathrm{O\,B} \times \frac{p\,\mathrm{M}}{p\,\mathrm{L} - \frac{1}{p\,\mathrm{K}_1}}$ and is of oppo-

site sign to O B, it must, therefore, be drawn upwards. (In practice, when working out the apparent impedance, it is unnecessary to find F or draw F G, but it is done here to make the principle of construction clear.)

Produce O F to B^1, making O B^1 = O B.

$\tan\theta = \dfrac{p\,N - \dfrac{1}{p\,K_2}}{r_2}$ and is positive, since $\dfrac{1}{p\,K_2}$ is supposed less than $p\,N$.

Hence $\theta = \tan^{-1}\dfrac{p\,N - \dfrac{1}{p\,K_2}}{r_2}$, and O D must be drawn, making this angle with O B^1. Drop the perpendiculars, B^1 D and F G.

Then $O\,G = C_2\,r_2$ and $F\,G = C_2\left(p\,N - \dfrac{1}{p\,K_2}\right)$

Now, $B^1\,D = F\,G \times \dfrac{O\,B^1}{O\,F}$.

Take H in B^1 D or B^1 D produced such that B^1 H = B^1 D × a.

Then $B^1\,H = F\,G \times \dfrac{O\,B^1}{O\,F} \times a$

$$= C_2\left(p\,N - \frac{1}{p\,K_2}\right) \times \frac{p\,L - \dfrac{1}{p\,K_1}}{p\,M} \times \frac{p^2\,M^2}{\left(p\,N - \dfrac{1}{p\,K_2}\right)\left(p\,L - \dfrac{1}{p\,K_2}\right)} = p\,M\,C_2,$$

and this is the E.M.F. developed in the primary, due to the induction of the secondary. The arrows show the direction of the vectors, reckoning from O as origin.

We have then to find the resultant of B^1 H, the E.M.F. in primary due to secondary, and O B, the E.M.F. in primary due to self-induction. This can be done in two ways: either draw B H^{11}, parallel and equal to B^1 H and join O H^{11}; or (and this is practically the quicker manner, unless a parallel rule be handy), produce H B^1 to H^1, making B^1 H^1 = B^1 H, join H^1 O and produce to H^{11}, making O H^{11} = O H^1. Then O H^{11} represents the E.M.F. in primary due to induction, and, consequently, H^{11} A the impressed P D or E_c necessary to produce current C_1 in it, since $C_1\,r_1$ is the resultant of the two vectors, O H^{11} and H^{11} A.

As before, if O A is made equal to r_1, and O B to $p\,L - \dfrac{1}{p\,K_1}$, A B represents I_1 to scale, and A H^{11} I to scale.

In practice a quicker way of drawing is shown in fig. 7.

Draw O A = r_1 O B = $p\,L - \dfrac{1}{p\,K_1}$.

O D is drawn, making an angle θ with O B as shown, where

$$\theta = \tan^{-1}\frac{p\,N - \dfrac{1}{p\,K_2}}{r_2}.$$

The perpendicular, B D, dropped in O D, and D B produced to H, so that B H = B D × a. Then A H is the impedance required or I.

We have now to consider the last case, when $p\,L - \dfrac{1}{p\,K_1}$ and $p\,N - \dfrac{1}{p\,K_2}$ are both negative. The first part will be the same as the third case, but $\theta = \tan^{-1}\dfrac{p\,N - \dfrac{1}{p\,K_2}}{r_2}$ and is negative, hence O D must be drawn, making an angle θ with O B^1, but on the reverse side to what it was in fig. 6. Drop the perpendicular, B^1 D, and take H, so that B^1 H = B^1 D × a.

Now $B^1\,H = p\,M\,C_2$ and is positive, and $G\,F = C_2\left(p\,L - \dfrac{1}{p\,K_2}\right)$ and is negative, so that the vector, H B^1, is oppositely directed to the vector F G, as shown by the arrows. The resultant E.M.F. in the primary is the vector sum of H B^1 and O B, and is to be obtained by joining H O and producing to H^1, so that O H^1 = O H. Then, as before, H^1 A represents the impressed P.D. on the primary, since $C_1\,r_1$ or O A is the vector sum of O H^1 and H^1 A. For the impedance diagram we can simplify by drawing it as in fig. 9.

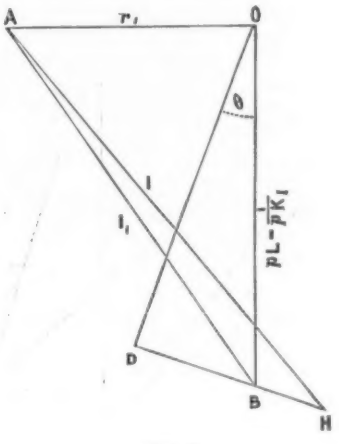


FIG. 7.

In either case, if a be greater than unity, H must be taken in B D or B^1 D produced.

Reviewing the impedance diagrams (figs. 2, 4, 7, and 9), for the four cases, we see in the first, O B is upwards and θ is positive and is set off behind O B, and H is taken on B D, or B D produced. In the second, θ is negative and is set off ahead of O B, and H is taken on D B produced. In the third, θ is positive and is set off behind O B which is now downwards, and H is taken on D B produced. In the fourth, θ is negative and is set off behind O B which is downwards, and H is taken on B D, or B D produced.

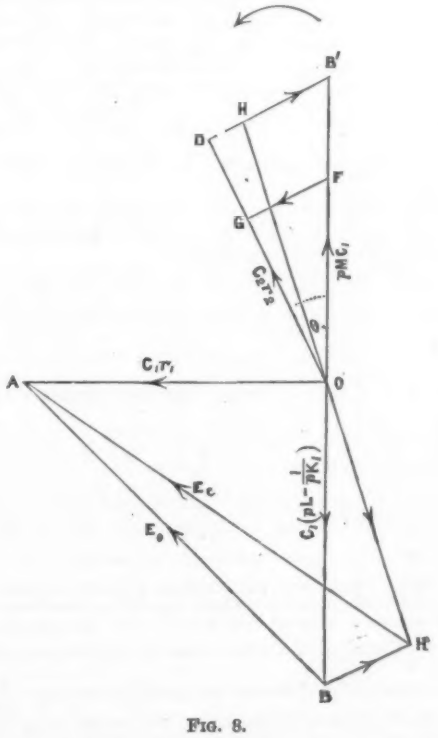


FIG. 8.

In all the above cases the angle of lag of the secondary current behind the primary is $\dfrac{\pi}{2} + \theta$, and lies, of course, between 90° and 180° when θ is positive, that is as long as $p\,N$ is greater than $\dfrac{1}{p\,K_2}$, but it lies between 0° and 90°

when θ is negative or p N is less than $\frac{1}{p\,K_2}$. When p N equals $\frac{1}{p\,K_2}$ or $p = \frac{1}{\sqrt{N\,K_2}}$ the angle of lag equals 90°.*

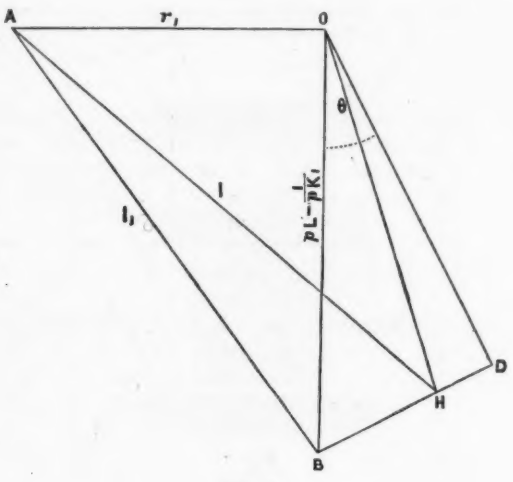


FIG. 9.

It may be of interest to note that $\frac{1}{2\pi\sqrt{N\,K_2}}$ is the frequency with which disturbances in the secondary circuit naturally oscillate, provided its resistance is small compared with $2\sqrt{\frac{N}{K_2}}$ which will in general be the case, or in other words when $p = \frac{1}{\sqrt{N\,K_2}}$ the secondary circuit is in resonance with the effect of the primary on it.

The same remark applies to any inductance in series with capacity, viz., the frequency at which the capacity annuls the inductance, leaving the impedance a minimum and equal to the ohmic resistance, is the natural frequency of the circuit (if its resistance were negligible compared to $2\sqrt{\frac{L}{K}}$) or $\frac{1}{2\pi\sqrt{L\,K}}$ and the current is, of course, a maximum and equal to the P.D. divided by the resistance.

Having found the apparent impedance of any primary circuit, it may be useful to here give the formulæ necessary for finding the secondary current.

Let I_2 be the impedance of the secondary and equal to $\sqrt{r_2^2 + \left(p\,N - \frac{1}{p\,K_2}\right)^2}$ (this can be found graphically if desired as in fig, 10).

Now $C_1 = \frac{E}{I}$ where E is the impressed primary P.D. The E.M.F. acting in the secondary equals p M C_1, and the secondary current or $C_2 = \frac{p\,M\,C_1}{I_2} = \frac{p\,M\,E}{I\,I_2}$.

The above are maximum values for the currents and the P.D., but if the virtual value (or square root of the mean square) of the P.D. is taken, as would be given by most measuring instruments, the values of the currents will be the virtual ones, since the virtual value equals the maximum value divided by $\sqrt{2}$.

Again, the power expended in the secondary, or

$$P_2 = E_2\,C_2\cos\theta = \frac{p\,M\,E}{I}\cdot\frac{p\,M\,E}{I\,I_2}\cos\theta$$

$$= \left(\frac{p\,M\,E}{I}\right)^2\cdot\frac{\cos\theta}{I_2} = \left(\frac{p\,M\,E}{I\,I_2}\right)^2\cdot r_2$$

where E is the virtual P.D.

The power impressed on the primary, or $P_1 = E\,C_1\cos\phi$,

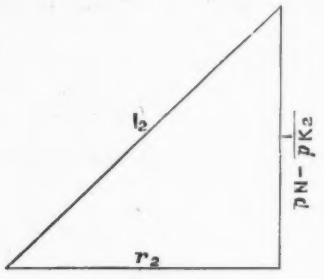


FIG. 10.

where ϕ denotes the angle O A H in figs. 2, 4, 5, 7 and 9, or $P_1 = \frac{E^2}{I}\cos\phi$.

ϕ can be easily measured on the diagram, and is, of course, the phase angle between the primary current and the impressed P.D., whose virtual value is E.

The power spent in heating the wire on the primary, or $P_R = C_1^2\,r_1 = \frac{E^2}{I^2}\,r_1$, and obviously $P_1 = P_2 + P_R$

or $$\frac{E^2}{I}\cos\phi = \left(\frac{p\,M\,E}{I\,I_2}\right)^2\cdot r_2 + \frac{E^2}{I^2}\cdot r_1$$

or $$\cos\phi = \frac{p^2\,M^2\,r_2}{I\,I_2^2} + \frac{r_1}{I} = \frac{p^2\,M^2\,r_2 + r_1\,I_2^2}{I\,I_2^2}$$

this enables cos ϕ to be calculated if required, but it is much easier to measure the angle from the diagram with a protractor, and look out the cosine in a table, or to obtain the cosine graphically thus: Take fig. 1 for example. From A mark off A P on A H some distance, say 2 inches. Drop a perpendicular P N on to A O, then A N in inches divided by 2, equals cos ϕ with quite sufficient accuracy for the purpose.

The above would not be correct if there were losses by hysteresis and eddy currents, and the effect of the former would be equivalent to increasing the resistance of the secondary by an amount r_x, so that $C_2^2\,r_x$ should equal the power wasted by hysteresis, the effect of eddy currents would be like having another closed secondary, and this would re-act on the primary altering its impedance. These effects have not, however, yet been properly taken into account, even by methods much more pretentious than the above.

CANAL BOATS DRIVEN BY ELECTRICITY.

THE mighty intellects engaged in harnessing the gigantic forces of electricity in America have at last found a problem commensurate with their skill. How to drive a canal boat by electricity has been one of those problems far beyond the powers of ordinary electrical engineers; it has remained to be solved by the great minds engaged on "propulsion" in America.

The first difficulties that were experienced in "materialising" the great scheme were on a scale of magnitude, only to be expected in such a stupendous undertaking. The men engaged on the construction of the trolley wire at the close of the very first day were overtaken by darkness and were compelled to suspend operations for the night. On the morrow it was discovered that the intricate measurements made to fix the wires at a proper height had been blundered,

* In this particular case to obtain the diagram we must proceed slightly differently, as in the ordinary way B H becomes indeterminate, since F G and B D equal zero and $a = \infty$. Consider fig. 1. As $p\,N - \frac{1}{p\,K_2}$ diminishes, F G and B D diminish, and the angles G F O and D B O approach 90°, and become equal to 90° when $p\,N - \frac{1}{p\,K_2}$ equals zero. Moreover, O G will equal O F, or O F represents $C_2\,r_2$. Now, B H is set off along B D and is to equal $p\,M\,C_2$, which is finite; we must then draw B H at right angles to O B (to the right), and make it equal to O F $\times \frac{p\,M}{r_2}$ (since O F $= C_2\,r_2$), or to O B $\times \frac{p^2\,M^2}{r_2\left(p\,L - \frac{1}{p\,K_1}\right)}$, since O F $=$ O B $\times \frac{p\,M}{p\,L - \frac{1}{p\,K_1}}$. Then, joining A H, this line will equal E_c.

In the impedance diagrams the same reasoning will apply.

and, during the night, some boat had fouled the wires, the canal boatmen had cut them in three different places to clear their boats, and, in consequence of these miscalculations and tremendous disasters, progress was delayed for nearly one whole day. It was also discovered that handling the scows was a great difficulty in a stiff wind. Despite all this the trolley wires were at last strung up and thus was one part of the great engineering work accomplished, and pronounced to be superb as a piece of construction. Meanwhile, a boat had to be got ready; there could be no propulsion without a boat. An old steam canal boat was procured with a propeller of the antiquated dish-pan type; why the propeller, which is a most important part of the outfit, should be of the dish-pan type is not reported. The most important alteration made on this old canal boat seems to have been to paint on a new name on the stern and on the port and starboard bows *Frank W. Hawley* writ large, this being satisfactorily accomplished without accidents worth recording, the engineers took out the old engine and boiler, and with the great skill so conspicuously displayed throughout, actually succeeded in connecting a 25 horse-power electric motor to the dish-pan propeller shaft. It is said that the canal boat looked after all this transmogrification quite like a street car on the water. All was now ready for a trial trip.

In the teeth of a stiff gale and in the presence of an admiring crowd, this first electric "propulsion" of a canal boat was inaugurated, the anchor was weighed, and the voyage commenced with a hold full of sand and the deck black with people; the curves, the locks, the bridges, and all the other very dangerous obstacles common to canal navigation, were successfully and safely passed to the intense satisfaction of the eminent electricians and engineers engaged on this colossal engineering enterprise, and canal boat propulsion was for the first time in the history of the world an accomplished fact.

Then the official trial took place, Governor Flower started the boat off with his own hands, and on reaching Lock 65 the Governor made a happy little speech. The total cost of this great work reached the magnificent amount of £1,000, of which the State will pay one-third, and there was a "State electrician" on board during this never-to-be-forgotten voyage, whose sole duty was to read the instruments and count the revolutions of the dish-pan propeller.

Everybody who is anybody in America was present at this auspicious event, Nikola Tesla, George Westinghouse, a Bishop of Rochester, two State engineers, and a crowd of other world-wide known celebrities, not to mention a representative of the gas company.

Of the practical results of this great experiment, it is perhaps too early to speak, one is lost in contemplation of the mighty results as yet but dimly perceived; so many possibilities arise that one might fairly exclaim: "We cannot see the forest for the trees."

The engineers who have carried this great scheme to this stage, now predict confidently that apparatus can now be provided for canal boat propulsion by electricity.

The *Electrical Engineer*, of New York, devotes 5½ columns and four large illustrations dealing with this experiment in their No. 290, November 22.

The first illustration is entitled "The Electrical Canal Boat," showing her fine lines at the stem, and a telegraph pole on the bank laying over at a graceful angle. Illustration No. 2 shows the exquisite lines of the stern of this famous boat, with the dish-pan propeller partly out of the water. No. 3 shows a group of men with their hands in their pockets, on the deck of the boat; two hair lines representing trolley poles are inclined over their heads. No. 4 shows the vessel passing a dangerous point in the canal, with the captain on the bridge and the crew all on deck.

The experiments were made on the Erie Canal. It is anticipated that power will be got from Niagara Falls for working the canal boats by electricity if the scheme is ever adopted.

Lynton and Lynmouth Electric Lighting.—Considerable alterations are intended to be made at the electric light station. The room containing the machinery is to be much enlarged for the purpose of accommodating additional plant.

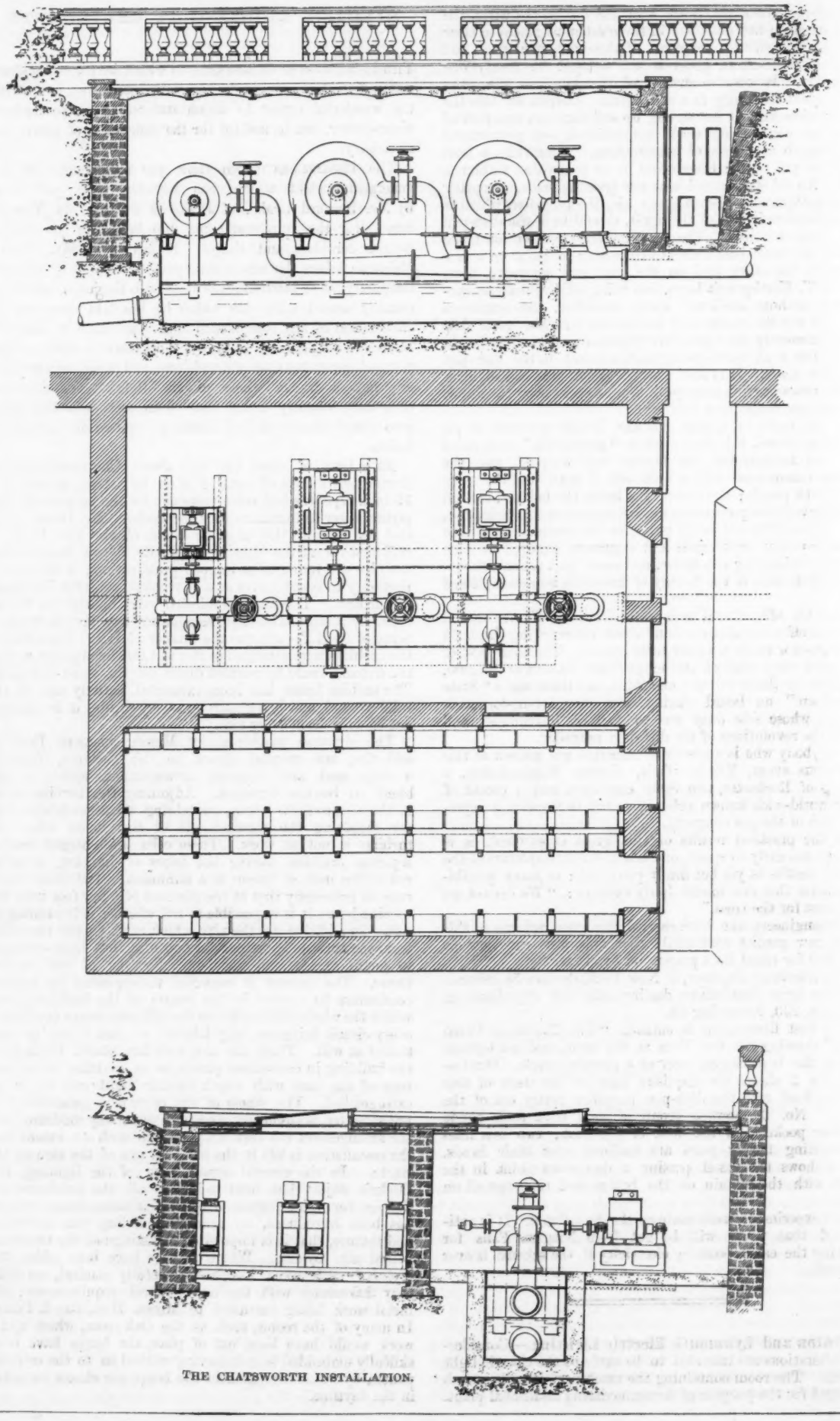
ELECTRIC LIGHTING AT CHATSWORTH.

THE installation at Chatsworth, to which we have previously referred in these columns, is especially interesting, as showing the wonderful extent to which natural forces, particularly water-power, can be utilised for the generation of power and electricity.

The illustrations given show the arrangement of the generating plant which has recently been put down by Mr. Bernard Drake, of Drake & Gorham, 66, Victoria Street, for the supply of some 850 lamps in the private rooms, corridors and chapel. It has been Mr. Drake's object to reduce the whole arrangement to one of absolute simplicity, as he attributes his success in the large number of country house installations which he has laid down to the elimination of any complicated apparatus which is likely to become deranged. It is always more easy to upset a complicated apparatus than a simple one, and it will be seen that at Chatsworth the whole of the lighting requirements of a large country house have been met, and the plant is so simple that no skilled labour is required in its manipulation.

At a level of some 400 feet above Chatsworth House there exists a lake of some 9 acres in extent, to which a 15 inch pipe was laid some years ago for the purpose of supplying water to fountains near the house. Mr. Drake found that by tapping this pipe he could obtain 150 H.P., or sufficient for all the lighting required. Upon examination, the pipe was found to be in good preservation; it was merely necessary to insert valves at a convenient point for the supply of turbines. The turbines selected were those of the Vortex type, by Messrs. Gilkes, of Kendal, the two largest turbines being of 50 H.P. each, and the smaller 25 H.P. The speed of the turbines were arranged to run at 1,000 revolutions, so that the dynamo could be coupled direct on the same bed-plate. The turbine house has been excavated entirely out of the solid ground, and being surrounded by shrubs, it is entirely out of view from every side.

The dynamo machines, by Messrs. Siemens Brothers and Co., are coupled direct to the turbines, forming a very neat and compact arrangement, which is not likely to become deranged. Adjoining the turbine house is the accumulator room, containing 60 accumulator cells for supplying the requirements of the house when the turbine is not at work. These cells are charged from a separate machine during the hours of lighting, so as to reduce the item of labour to a minimum. The whole plant runs so noiselessly that at the distance of a few feet from the turbine house it is impossible to tell whether it is running or not. In addition to the pipe which carries away the water from the turbines, a large safety opening has been arranged to guard against any accidental flooding of the turbine house. The current is conveyed underground by massive conductors to a point in the centre of the building, from which the whole distribution to the different rooms is effected, every circuit being carefully labelled so that it can be controlled at will. There are also switches placed throughout the building in convenient places, so as to take full advantage of the ease with which electric light can be lit or extinguished. The whole of the current is generated at a pressure that is absolutely innocuous under any condition, and the arrangement has been simplified to such an extent that the installation is left in the hands of one of the men on the estate. In the general arrangement of the lighting, Mr. Drake's object has been to utilise all the handsome old fittings, for which purpose a special imitation electric candle has been introduced, so nearly resembling wax in colour and texture, that it is impossible to distinguish the two when placed side by side. Where fittings have been added the style of each room has been carefully studied, so that they harmonise with the architectural requirements; the metal work being entrusted to Messrs. Hart, Son & Peard. In many of the rooms, such as the Oak room, where metal work would have been out of place, the lamps have been skilfully embedded in oak carving worked in to the original panels, by which arrangement the lamps are almost invisible in the daytime.



THE CHATSWORTH INSTALLATION.

To avoid the complications due to the supply of current from a dynamo which is charging the accumulators owing to the rise of E.M.F. according to their state of charge, the switchboard has been arranged so that the small machine can be employed for charging the accumulators while the house circuit is run direct from the larger machines, which are connected either singly or in parallel, as required. The arrangement also provides for the small machine and the accumulators being worked together in case of emergency for the supply of the house.

Precautions are taken in the switchboard to prevent any accident due to the switches being moved in the wrong order.

Owing to the high fall available, special precautions had to be taken to prevent any sudden stoppage of the water, which would produce a jar on the pipes. A previous attempt to provide a valve at the lower end of the pipe, so as to avoid having to climb the mountain whenever the fountains were required, has entirely failed from this cause. To meet this, a 3-inch by-pass is provided for every valve, so that after the main valve has been closed, the by-pass can be manipulated; this expedient has been found to be thoroughly successful.

The current is conveyed to the house by means of armoured cables more than $\frac{1}{2}$ an inch in sectional area.

This cable leads to the main distributing switchboard in the centre of the building, as we have previously mentioned, a pilot wire being brought back from this point to the dynamo room to enable the engineer to keep the voltage constant at point of distribution. The voltage at the house is maintained at 105, and the whole of the wiring is on the parallel system.

The accumulators are of the "D.P." type, capable of discharging at 120 ampères for four hours.

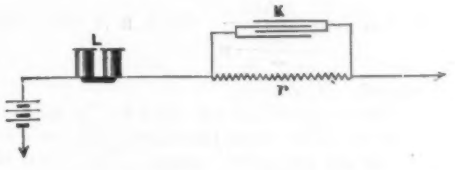
THE THEORY OF THE READING CONDENSER IN AUTOMATIC TELEGRAPHY.

By J. E. TAYLOR.

A COMPLETE non-mathematical explanation of the increase in speed of automatic working when a shunted condenser is placed in series with the receiver, still remains to be published. The following may perhaps be a satisfactory explanation.

The present method of automatic working at high speed with the aid of a reading or compensating condenser is, in some respects, similar to, but an improvement on the older one in which a resistance was automatically brought into the circuit immediately after the commencement of each signal. The value of this arrangement is apparent when we consider the unequal duration of the currents producing the signals of the Morse code, and if all the currents were of uniform duration the system would have no advantages whatever as far as speed of working is concerned. A useful analogy has been drawn between the setting in motion of a heavy body to the progress of which some resistance is offered, a constant motive force being applied, and the magnetisation of an electro-magnet. In the same way that a large motive force will more quickly give the body a certain speed which is within the range of another smaller force, than that smaller force itself would do; so a high E.M.F. will produce a certain amount of magnetic induction through the core of an electro-magnet, which is within the range of that producible by another smaller E.M.F., more quickly than that smaller E.M.F. would under the same conditions. The moral of this is, of course, that a high E.M.F. should be used if high speeds of working are aimed at. But, unless means be adopted to prevent it, the use of a high E.M.F. will produce a great deal too much magnetic induction in the electro-magnet of the receiver during a prolonged current and thus polarise the iron so that the succeeding reverse current of short duration has perhaps no more effect than to destroy some of this polarisation. There are, in fact, two effects antagonistic to high speed working which require to be overcome. These are: Firstly, polarisation of the iron; and secondly, slow rise of magnetic induction in the iron. The first is overcome by preventing the current strength rising to too great a value; the second which is caused by the back E.M.F. of self-induction opposing every reversal of the direction of the current, is overcome by the application of a high E.M.F. as previously explained in the analogy of a heavy body being set in motion. So far, then, the old method of introducing a resistance immediately after the commencement of a current fulfils these conditions. The condenser method is, however, more effective, inasmuch as in addition to doing the work of the inserted resistance it also increases the E.M.F. just when a high E.M.F. is required.

In the figure, L is the electro-magnet of the receiver, and K, the condenser shunted by a resistance, r. When the



condenser is not charged it acts as a short circuit across the resistance, r, and as it is charged it is equivalent to a corresponding rise in its resistance considered as a shunt across r, until when charged up to the potential difference at the terminals of r its resistance has risen to infinity. Thus the resistance, r, is brought automatically into the circuit soon after the commencement of each current. During discharge the condenser acts not only as a short-circuit but as an additional battery joined in series with the other, for as soon as the sending battery is reversed, its positive end is put in connection with the negatively charged side of the condenser and its negative end with the positively charged side through the line or earth as the case may be. In this way the reversal of the magnetic induction in the iron is quickly effected, and at the same time, by giving suitable values to the capacity of the condenser and to the resistance, r, the current is kept below a certain limit. It would also appear that for a given coefficient of self-induction in the receiver coils, there is a certain capacity which should be given to the condenser to obtain the best results. If it were too large it would defeat its own ends by prolonging the short-circuit of r, and thus polarising the electro-magnet, and it should, therefore, be as small as is consistent with its function. On the other hand, we can go on increasing the resistance, r, as we increase the battery power to any extent necessary for the production of good signals, but it should also be borne in mind that on lines of much electrostatic capacity the line retardation is increased by increasing either of these factors.

It is commonly said that the charge and discharge of the condenser overcomes or neutralises the back E.M.F. and extra current of the receiver coils. This is, however, misleading, as the charge only aids the rising of the current, although consequent upon this more rapid rise there is a greater back E.M.F., whilst the loss of magnetism in the coils, consequent upon a reversal, is so rapid that the extra current's E.M.F. probably overcomes the working E.M.F. for a small space of time, and it is this time only that is shortened by increasing the working E.M.F.

THE VARIATION IN ECONOMY OF THE STEAM ENGINE DUE TO VARIATION IN LOAD.

MR. R. C. CARPENTER discusses this question in a paper read at the tenth general meeting of the American Institute of Electrical Engineers, and endeavours to find a formula which shall express the economy for different loading as found by actual tests. He starts from the proposition that the steam consumption of an engine is made up of two parts, one being that due to the work of the perfect engine, the other, that due to the wastes.

Of course in the perfect engine there is no waste, and the

consumption will vary with the work done, whilst the wastes must always bear a larger ratio to the net work in the case of an underloaded than of an overloaded engine.

By a perfect engine he understands the engine working on the Carnot or reversible cycle, but it was not found altogether satisfactory to use such an engine as a standard. The formula for the Carnot cycle, slightly modified however, gave a standard of comparison closely agreeing with the practical tests, and this was adopted. The efficiency of the perfect engine being $e = \frac{T_1 - T_2}{T_1}$, the heat units per hour per horse-power for the perfect engine will be $\frac{2,545}{e}$, and in Carnot's cycle the available heat per lb. of steam is, of course, the latent heat of the initial steam. Hence the actual steam consumption will be $\frac{2,545}{\frac{T_1}{T_1 - T_2} R}$ where R is the value of the latent heat of a lb. of steam.

But the standard engine does not work on Carnot's cycle; it rejects steam at a point where the latent heat has a larger value than it has for the initial steam. Hence the steam consumption of the standard engine will be $\frac{2,545}{\frac{T_1}{T_1 - T_2}(l - q)}$ where l is the total heat and q is the heat of the liquid in the exhaust steam, the expression $l - q$ being, in fact, the really available latent heat as between T_1 and T_2. A table is given purporting to be calculated from this latter formula, and giving the steam and heat consumption for steam pressures up to 200 lbs. absolute and back pressures of 2 lbs., 5 lbs. and 14·7 lbs., but unless we are mistaken the figures given are for the Carnot engine, not for the standard engine.

Now Thurston considers that the wastes of an engine vary with the square root of the expansion ratio. Cotterill finds them to vary with a logarithmic function of this ratio, and for four expansions the two propositions are practically alike. Mr. Carpenter deduces two formulæ, simple in application, A for underloaded, and B for overloaded engines, and his results are all expressed in terms of I.H.P. By a properly loaded engine is understood one working at most economical load.

What the most economical load may be is not stated, but it is given as m = I.H.P. for best results.

Then w = steam consumption per hour for m horse-power.
p = standard engine consumption.
$b = w - p$ or the least waste.
n = any other horse-power more or less than m.

Then when n is less than m, the case of underloading, the steam per I.H.P. per hour

$$= y = p + b\sqrt{\frac{m}{n}} \qquad \text{(A)}$$

or

$$= y = p + b\sqrt{1 + \left(\log \frac{m}{n}\right)^{\frac{m}{n}}} \qquad \text{(B)}$$

Where n is greater than m, the case for overloading, the above two formulæ are repeated, except that m and n are transposed in every case where they occur.

A table is added giving the value of $x = \frac{n}{m}$ or $\frac{m}{n}$ for values from 1 to 10 with the hyp. log., and the value of the logarithmic expression of formula B.

The application of the formulæ is shown in many cases of actual tests of different varieties of engines, and the actual results agree very closely with the two formulæ. We suppose that the best rate of work in the actual tests was ascertained by observations at several different rates, but how is m to be fixed for any hypothetical engine?

In the case of a Parsons steam turbine, formula A practically agreed with the actual water consumption per electrical horse-power, which Mr. Carpenter thinks will be equivalent to the indicated horse-power, there being so little friction in the turbine. Generally he would use formula A as being simpler, and he deduces the general ratio of waste to the consumption of a perfect engine, as from 0·5 to 0·8, except in extreme cases, being generally lower for non-condensing engines than for those of condensing type. Such ratios are tabulated for a number of types as a guide.

Though so much of the gain noted in compound engines is due to the higher pressures, the author does not consider that simple engines would show equally good results, and is confident that the number of cylinders must be increased for higher pressures if the various wastes are not to increase unduly as compared with the usefully applied steam. The value of m he thinks may be the maker's rated horse-power, and giving to b the value which is now tabulated and varies from 23·1 for small high pressure throttling engines to 5·85 for good triple-expansion condensing engines, he would use the formula,

$$y = b\sqrt{x} + p,$$

where x is the ratio (always greater than unity) of m and n.

The formula would indicate that, of any variation from standard loading, an addition is preferable to a reduction, and in cases of a variable load the engine should not be larger than sufficient to carry on work over the peaks of a load diagram. He is fully satisfied that for variable loads the best results will be found with the most economical type of engine; this he considers shown by actual tests.

The only claim for consideration of his formula, which he makes is that it gives results in agreement with general practice, and therefore shows the formula to be applicable to everyday practice.

As showing the difference due to excellence of construction, he has made a test of a Corliss triple expansion pumping engine between the limits of 136 lbs. initial and 2 lbs. exhaust pressure where the actual water rate was only 11·79 lbs., for which case the Standard engine would ask for 8 lbs., showing a waste ratio only ·47, a lower result than he tabulates, and probably the best result ever attained with an engine of the type. He considers, therefore, that for poor or super-excellent construction results may vary 10 per cent. from what his formula shows.

Supplementing his paper read before the American Institute of Electrical Engineers, Prof. Carpenter has added some further information relative to the amount of friction for different classes of engine, taking as an axiom that the loss due to friction is practically identical for all loads, and, therefore, a heavily loaded engine has, *ceteris paribus*, a better mechanical economy by reason of the distribution of the steam consumption due to friction over a greater number of power units. He compares the friction of as many engines as he has been able to find recorded, though this number is but limited, and he concludes that there is no great difference for different classes of engines, but that large engines have a less percentage than small ones.

It appears to vary from 5 to 9 per cent. of the rated load in non-condensing engines of 150 H.P. or over, whether simple or compound, and from 6 to 12 per cent. in condensing engines of 50 to 150 H.P. The air pump adds 2 to 3 per cent. upon such engines as have it fitted; as distinguished, we may suppose from those using the condenser of another engine or fitted with the ejector condenser.

The average friction for engines of 50 to 150 H.P. he takes to be 10 per cent. for non-condensing and 13 per cent. for condensing up to 150 horse-power, beyond which 7½ and 10 per cent. may be respectively assumed.

In a test of the engine at Sibley College when run as a simple, a compound, and a triple engine with equal boiler pressure, in each case of 100 lbs., with 21 inches vacuum:—running simple condensing only with H.P. cylinder at 62 to 83 I.H.P., the average friction was 6·8 horse-power. Running compound with high and intermediate cylinders at from 63 to 91 I.H.P., the friction averaged 8·2 I.H.P., and when running triple expansion the friction was 16·9 I.H.P. for powers of 63 to 131 I.H.P. Subsequent tests proved the economical loading in each case to be 62·4, 85, and 145 to 150 I.H.P. respectively, and the friction percentages on this basis work out at 10·8 per cent., 9·65 per cent., and 11·2 per cent., the excessive friction of the large cylinder being attributed to the comparatively few times this engine has been run in triple expansion.

A table is given, worked out from the percentage of friction, and previous figures which shows that per delivered horse-power—*i.e.*, brake horse-power—the work of an engine may be raised fifty per cent. without very material increase of the water consumption per useful or brake horse-power. This emphasises the importance of not providing engines too large for their duty, as is often done, as though the I.H.P. was the sole basis of water measurement instead of the brake horse-power.

ROPE POWER TRANSMISSION.

IN writing on this subject in *Cassier's Magazine*, Mr. J. M. Dodge gives some particulars of rope driving as practised in America. Direct and simple as are many American methods, we do not think there is much of either quality in the so-called American system of using one long endless rope in combination with a tension pulley, and, of course, a cross-over. Manila rope seems to find favour in America, solely, we should imagine, because of its small first cost, for it fails in many other respects as compared with cotton. Exposed as ropes are to continuous bending over the sheaves, it is impossible that the rough surfaces of the large and uneven fibres of a Manila rope can be lubricated in a manner to render them durable. Surely the long experience in Europe of cotton ropes might be allowed a little more weight by the Americans, especially as America is a producer of a class of cotton well suited for spinning into rope yarns.

Cotton is not merely suitable for ropes from the fact that each strand of the rope is made from a large number of hard spun fine threads, and so there is little vacant space in the rope, but also because it forms a flexible rope which will not absorb much power in bending or in bedding to the grooves. Cotton has also a better grip on a cast-iron groove than manila.

It is a mistake to conclude that the English practice of using cotton ropes is entirely due to the desire of the Lancashire power users to employ a material made from their own yarns. The first main driving by ropes was carried out in Dundee, and naturally with hemp or flax ropes—the local product. The system was rapidly taken up in Lancashire, but with ropes of cotton; and cotton was used simply because it always had been used in Lancashire for machine driving, the custom being to drive the individual spinning spindles, which revolved at speeds of 10,000 revolutions per minute, with little cotton bands about $\frac{1}{16}$th inch diameter. The rollers of carding engine were driven by cords of $\frac{3}{8}$ths inch diameter, while the long tin rollers, which were the drivers of the little spindle bands, were driven by cords, or small ropes, termed rim bands, having a diameter about $\frac{3}{4}$ths of an inch. The rims, or sheaves, had conical grooves like main driving rims, and main driving was therefore but an advance in dimensions upon methods of many years standing. Bands, *i.e.*, the little cords of circular section above described, were employed by Hargreaves, the inventor of the spinning frame. Arkwright, who invented the "throstle," used flat tapes to secure a better grip, because, by his system, the spindle always worked against what was in effect a friction brake, and the spindles could not be so well driven by bands, though these in later years did again come into use. The band, however, has always been used on the "mule" spindle.

In a cotton rope of 2 inches diameter, there will be 80,000 threads of No. 32 twist, the number 32 indicating that 32 hanks of thread will weigh one pound; a hank is 840 yards. In a thread of 32s twist, there are, according to Bowman, 144 fibres of American cotton and a wrapping of 80 threads, giving the strength of 160 threads, should have a tensile strength of 50 pounds, which is about one-fifth the strength of the natural fibre. The breaking strength of a 2-inch rope would appear therefore to be 25,000 pounds, if based on the ratio of the 160 threads of the tested sample to the 80,000 threads in the rope. This is probably far in excess of the strength of the whole rope, which has less resistance than the sum of the resistances of its individual threads, as have these less than the strength of their constituent natural fibres.

Reverting to Mr. Dodge, however, we note he does not approve of wire ropes for driving purposes. Now we have found wire ropes, though made up of a few coarse wires only, to work satisfactorily for years, and we should think it very probable that the ropes used in America for elevator work would prove good driving ropes under suitable conditions.

The advantages claimed by Mr. Dodge for the tension carriage, viz., to take up slack and allow for variations due to weather, are not borne out in practice. After once being taken up, ropes run for long periods, and slackness on the idle side seems to count for little in practice. Those who ask for a certain proportion of slack side tension overlook a very important practical fact. The increase of grip due to wedge grooves adds largely to the capacity of a rope, but there is a longitudinal wedge action which is usually overlooked. The rope on its driving sides sinks more deeply into the grooves than on the slack sides. Any attempt to slip would thus imply the pulling of the rope into a long wedge groove, whose length is the half circumference of the driven pulley. Slack side tension may be practically overlooked, a fairly cambered catenary only being sought for. New ropes are, of course, to be put on very tight. This is effected by lashing them to the rim and turning the flywheel of engine itself. The bearings of the driven shafts should be double, no driven pulley being on an overhanging shaft, and the bearings should have a length of five diameters.

Mr. Dodge refers to the lubrication of Manila ropes. Now a wire rope can be lubricated, but no amount of lubrication will prevent fish-hooks from interlocking, and in a sense lubrication can only beneficially affect a Manila rope by rendering it less brittle. Cotton ropes are treated with certain compounds to prevent them from fluffing, and to give them grip and smoothness. Plumbago and tallow has been used, and on smaller ropes, like mule bands, plumbago and treacle have been used to prevent slip, these bands being exposed to sudden stresses in starting their load from rest many hundred times daily.

Where room is an object, ropes of 2 inches diameter will give a greater power per foot of space occupied than will smaller ropes, but a 2-inch rope is not a very usual size. The Lancashire standard is probably $1\frac{3}{4}$ for large 1,000 H.P. engines. For electrical units of 200 H.P., ropes of $1\frac{1}{4}$ inch diameter would be very suitable, eight such being sufficient. It seems reasonable to suppose that apart from the lesser strains imposed by bending on the smaller ropes, a small rope secures a larger ratio of the strength of its individual threads than does a large rope. Makers of ropes at one time were very favourable to the 2-inch rope, and so were some of the engine makers, who saw in smaller ropes the disadvantage of a wide pulley. The American system is rather in favour of 1 inch and $1\frac{1}{2}$ ropes, but these are too small, a minimum size for small powers being the $1\frac{1}{4}$ inch. For 500 H.P. the ropes may be $1\frac{1}{2}$ inch, and for 1,000 H.P. $1\frac{3}{4}$ inch may be employed. Where small pulleys must be used on the dynamo we are practically compelled to use small ropes if we adhere to the rule of having no sheave less than 30 diameters of the rope, and it is only in such cases that we think the American system may be employed, possibly with advantage, but for small pulleys, belts still have an advantage over ropes, and these should really be discarded for thin belts where the conditions indicate such a course.

W. H. B.

REVIEWS.

A Text-Book of Heat. By R. WALLACE STEWART, D.Sc. London: W. B. Clive, University Correspondence College Press, 13, Booksellers Row, Strand, E.C.

This work is the second volume of "The Tutorial Physics" issued by the University Correspondence College Press. If we were asked to recommend a text-book of heat we should have little hesitation in naming Dr. Stewart's compilation, not because it has any particular merit of its own but because it is a treatise which is quite as good as others which have been written.

Every Doctor of Science must have his text-book or text-books, and a publisher to publish it, quite irrespective of whether there is any real need for the volume or not. There is, doubtless, always a demand for scientific

books, simply because they are new, and we have no right to condemn anyone who brings out a treatise if it is sound and if it sells; but at the same time those who issue them can hardly expect much enthusiasm on the part of the reviewer who witnesses the piling up of mountains of literature, and who finds it every day more desperately hard to pick out special novel features in new books which he can praise or otherwise.

The inclusion of a number of questions and answers (in many cases with the working out given), is an excellent feature in the book.

The Incandescent Lamp and its Manufacture. By GILBERT S. RAM, A.I.E.E. London: The *Electrician* Printing and Publishing Company, Salisbury Court, Fleet Street, E.C.

This work is a very creditable production, and will prove of value to students and manufacturers. To those studying incandescent lamps with a view to improvement, it is of great value to know what has been done by others; to some extent this information is given herein. The book does not profess to give all the processes of manufacture, the author wisely confining himself to processes with which he is personally acquainted; thus, in treating of materials in preparation for forming filaments, he describes the Swan parchment-cotton process in detail, and only mentions a few other processes; this is the weakest part of the whole book. To the selection and preparation of the material the difference between one lamp and another is entirely due, and information regarding the treatment of silks and grasses, and their preparation would have been of the utmost value; filaments can be made also by depositing carbon from hydro-carbon fluids; this process is not referred to.

The making of carbon filaments may be said to be the art of incandescent lamp making; all the rest of it is simple mechanical operation, and processes, and these operations are minutely and fully described and illustrated in this work.

Mounting the filaments, flashing, and jointing are treated in great detail. Vacuum pumps of the best types for factory work are also very fully discussed. The limit of 100 or 110 volts fixed for incandescent lamps might have received more attention; improvements must go on in the direction of a higher pressure, mainly for the purpose of saving copper in the mains. The tubular carbons referred to by the author he admits take less current and a higher pressure than solid carbons of same length and diameter.

It is altogether a very good treatise on the subject, and a credit to its author.

Kalendar für Electrotechniker (Almanac for Electrotechnicists). Compiled by F. UPPENBORN, Principal Editor of the *Electrotechnische Zeitschrift*, of Berlin. Eleventh year, 1894. With 221 illustrations and two tables. Munich and Leipzig: Oldenbourg.

This very copious and ably compiled volume has experienced a variety of improvements and extensions. Several sections have been re-written. Such are the chapters on the sub-division of currents, the examination of iron, the measurement of alternating currents, dynamos and transformers, the construction of glow lamps, the transmission of power, and on electro-chemistry. The sections on the construction of transformers and on electrical railways are entirely new.

The tables of resistances have been re-calculated on the basis of the new ohm = 1·063 Siemens units.

As in most continental almanacs, opposite the days there are placed, not events of scientific or general interest, but the names of persons, many of whom are probably mythological and certainly useless. After these follow the dates of prominent discoveries in electricity and its applications.

In the body of the work we meet first with mathematical matter, with logarithms and anti-logarithms of the natural numbers carried out to four figures, the trigonometric numbers, tables of squares, cubes, square and cube roots, &c., of all natural numbers.

Then follow weights and measures, with the mutual conversion of the metric and the English standards. It might have been useful to add that the American weights and measures are not in all cases identical with those of England.

In the physical section we have tables of specific gravities of solids, liquids, and gases. Acoustics take their place here in consequence of the invention of the telephone. In optics we find directions for photometry, with the light-units recognised in England, France, and Germany. Particular attention is given to the photometry of arc lights.

Under thermotics come tables of specific heats, the comparison of the thermometric scales, tables of melting points, and of combining heats.

Magnetism and electricity are, of course, treated at much greater length and lead the way to electro-technics, properly so-called. Here we find amidst other useful and appropriate matter, compact, but clear and comprehensive, accounts of electrical machines, the electric light, electro-chemistry, the electric transmission and distribution of power, and telegraphy.

The work, as a whole, is characterised by accuracy and comprehensiveness, so that the reader is forced to admire how so much matter has been compressed into so little space.

The almanac is got up in pocket-book shape and is well printed, though the type is of necessity very small and requires a very good eye-sight. We must recommend it to all of our readers who are acquainted with the German language.

The Principles of Fitting. By a FOREMAN PATTERN MAKER. London: Whittaker & Co., Paternoster Square.

This book is a partial re-arrangement of a series of articles which appeared in the *English Mechanic*. It is decidedly a useful work, especially to the amateur. For technical classes it should prove invaluable, as the whole of the matter is thoroughly practical, and, moreover, is written by a man who knows what he is writing about. The subject of lathe work is not included, though it would be a great advantage if a few "wrinkles" with reference to the same could be given; the author could doubtless give the benefit of his experience in this direction.

The Glasgow and West of Scotland Technical College Calendar for 1893-94.

This calendar is of the usual description and gives full details with reference to the very complete sources of instruction which the college affords.

Engineering, Drawing, and Design. By S. H. WELLS, Principal of, and Head of the Engineering Department in the Battersea Polytechnic Institute, &c., &c. Vol. I.—Geometry, Practical, Plane and Solid. Vol. II.—Machine and Engine Drawing and Design.

The first part of this work contains an excellent selection of problems in plane and solid geometry, including all that the engineers' draughtsman will require in ordinary practice. We have geometrical constructions for lines and angles, construction of triangles and polygons, problems on loci, curves for wheel teeth, interpenetration and development of solids and isometric projection, sufficient demonstration being given in each case to enable the student to understand the *rationale* of the construction. The second part, which will be the more interesting to the student of machine design and drawing, is arranged on an excellent system calculated to impart an intelligent grasp of the subject, and not the mere faculty of mechanical copying. Each of the more common parts of machines are discussed separately; the principles on which their dimensions are determined are treated not merely from a high and dry theoretical standpoint, but with a thorough appreciation of the modifications that have to be introduced to facilitate their production in the factory. Having discussed the details, Mr. Wells proceeds to show how to make a complete drawing of a complicated machine, taking two examples—a high speed vertical steam engine of 35 H.P., and a horizontal engine, with a jet condenser, of 25 H.P. He shows how to make complete working drawings, discussing fully each step in the design; anyone working through this part of the book will be the possessor of a valuable set of working drawings, in addition to what knowledge of the subject he may have acquired. The book will form a

THE "ELECTRIC

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ELECTRIC LIGHT CENTRAL STA

ABERDEEN.—Corporation. L.T. three-wire system with storage. Willans & Robinson engines, Babcock boilers. Underground mains, bare copper strip in concrete culvert. 10 10-ampère arc lamps used for street lighting. Price per unit, 7d. Gas 3s. 8d. Gas coke used for boilers. Arc lamps run 4 in series across 220 volts. The station is not yet completed. Consulting engineer, Prof. Kennedy. Resident Engineer, Mr. E. T. Ruthorn Murray, Corporation Electric Light Station, Aberdeen.

BATH.—Bath Electric Lighting Company. Thomson-Houston machines for street lighting. Brush Company alternators for private supply. Babcock boilers, Raworth engines. 84 arcs for street lighting, 22 arcs and 7,000 8-C.P. incandescent for private lighting; capacity of station, 10,000 incandescent and 200 arcs. Callender underground mains. 750 lamps added during the past year. Station cost £35,000. Coal consumption in 1892 was 10 lbs. per unit. 6d. per B.T.U.; gas 2s. 8d. per 1,000 feet. Manager and Engineer, Mr. G. F. Metzger, 7, Dorchester Street, Bath.

BIRMINGHAM.—Birmingham Electric Supply Company, Limited. L.T. system. Willans engines, Lancashire boilers (1,400 H.P.), and Crompton dynamos. Underground mains, feeders consisting of copper strip in culvert, on Crompton system; distributing mains on Callender's solid system. No street lighting; 90 arcs and 9,400 16-C.P. lamps for private lighting. 2,300 16-C.P. lamps added during the past 12 months. Capacity of station, 11,500 16-C.P. lamps. Price per unit, 8d., with sliding scale; gas 2s. 7d., with sliding scale. Engineer, J. C. Vaudrey, 14, Dale End, Birmingham.

BLACKPOOL.—Corporation. H.T. alternating (2,000 v.) for private supply. Series arcs for public lighting Fowler engines, Lowrie-Hall alternators, Brush arc machines. 3,200 8-C.P. lamps connected, and 101 arc lamps for street. Price per unit. 6d. Station cost £30,000; mains, £7,000. Capacity of station, 12,500 8-C.P. lamps and 165 arc lamps of 2,000 C.P. Engineer, John Hesketh.

BOLTON.—Corporation. H.T. alternating with sub-stations. L.T. network on a three-wire system. 3 Lancashire boilers and 3 engines being put down. Underground mains. H.T. concentric vulcanised rubber, in iron pipes; L.T. Siemens triple core armoured cable. Price per unit, from 5½d. to 8d.; gas, 3s. 2d. Use of coke breeze contemplated. Estimated outlay, £21,000. Station now being built. Engineer, J. H. Rider, Town Hall, Bolton.

BOURNEMOUTH.—Bournemouth and District Electric Supply Company. H.T. alternating current. Mordey-Victoria alternators and Brush engines, Babcock boilers. Mains, armoured cables drawn into cast-iron pipes. 14,500 8-C.P. incandescent lamps, wired for private supply. 5,512 lamps added during past year. Capacity of station, 15,000 8-C.P. lamps. Price per unit, 8d.; gas, 3s. 6d. Engineer, J. Rance, jun., Observer Chambers, Bournemouth.

BRADFORD.—Corporation. Two-wire low tension system with batteries. 7 Siemens dynamos, Willans engines, and 5 Lanc. boilers. Siemens armoured cable (underground). 26,263 8-C.P. lamps connected for private lighting, 11,000 lamps added during past year. Station cost £36,884; mains £9,587. Price per unit, 5d. for light; power 4½d. Price of gas, 2s. 3d. Revenue per 8 C.P. lamp, 7s. 6d. Extension on three-wire system. Engineer-in-Chief, Sydney W. Baynes, Town Hall, Bradford.

BRIDLINGTON.—Municipal Authority. Thomson-Houston arc-lighter. Motive power hired from sawmill. 18 arcs of 1,200 C.P. each. Lamps run during summer season. No return since last year. Engineer, R. Railton Brown.

BRIGHTON.—Corporation. L.T. two-wire system. Goolden and L. Clark and Muirhead dynamos, Willans engines (6). Total I.H.P., 1,960. 6 Lancashire boilers. Underground armoured cables. 40 arcs used for street lighting. 18,000 8-C.P. incandescent for private lighting. 8,000 added during past 12 months. Price per unit, 7d., and 3½d. after two hours' daily use. Gas 2s. 9d. Coal, 20s. per ton. Cost per unit in 1892, 3·76d. Revenue per 8 C.P., about 11s. Engineer, Arthur Wright.

BRIGHTON.—Brighton and Hove Electric Light Company. H.T. system with house transformers (2,000 v.). Fowler engines, 4 Lowrie-Hall and 1 Mordey alternators. 17,000 8-C.P. lamps connected, about 1,500 added during past year. Price per unit, 7d. in Brighton, and 8d. in Hove. Gas 2s. 9d. Coal consumption per unit delivered, 13 lbs. Revenue per 8 C.P., 11s. to 11s. 6d. Manager, G. W. Spencer Hawes. Engineer, G. J. Philpott.

BRISTOL.—Corporation. H.T. alternating current system, with low tension distributing network. Arc lighting by continuous current. Lanc. boilers, 8 Willans engines, Siemens dynamos and alternators. Underground mains, Siemens concentric cables, triple armoured, single armoured for arcs. 96 arcs for street ligthing, 14,000 8-C.P. incandescent for private use. Capacity of station, 20,000 8-C.P. Price per unit, 6d.; gas, 2s. 10d. Cost of station, £70,000; mains, £16,750. Engineer, H. Faraday Proctor, Electric Lighting Station, Temple Back, Bristol.

BUCKINGHAM.—Buckingham Electric Light Company. L.T. system with accumulators. 20 H.P. by water, 20 H.P. by steam. Elwell-Parker dynamos. Overhead wires. About 3,000 16-C.P. incandescents used for private lighting. Station cost £1,200. No return since last year. Engineers, Rogers & Son.

CAMBRIDGE.—Cambridge Electric Light Company. H.T. alternating system (2,000 v.). 2 Lancashire boilers, 3 Parsons steam turbo-alternators. Underground mains, vulcanised rubber cables placed in iron pipes. About 3,000 10-C.P. incandescent lamps are connected. Present capacity (actual) of station 300 units. Cost of station up to September 1st, was £26,000. It is expected that the ultimate capacity of the station will be 30,000 10-C.P. lamps. Resident Engineer, Arthur Ellis.

CHAGFORD.—G. H. Reed. H.T. alternating system with Hedgehog transformers. Siemens dynamos. Underground mains, lead covered, paraffin paper insulation. 300 8-C.P. for private lighting, 20 32-C.P. for outdoor lighting. Station cost £2,000. No return since last year. Engineer, George Reed, The Factory, Chagford.

CHATHAM.—Chatham, Rochester, and District Electric Lighting Company. H.T. alternating system with house transformers. 3 Babcock and Willcox boilers, 1 Robey and 2 Marshall's engines, 2 Ferranti dynamos, and 2 Brush arc machines. Capacity of station, 8,600 8-C.P. lamps Managing Director, H. Hurrell, Fair View, New Brompton, Kent.

CHELMSFORD.—Chelmsford Electric Light Company, Limited. H.T. alternating and continuous current arc lighting. Multi-Lancashire and Paxman boilers. Willans engines, Crompton dynamos. Overhead and underground mains. 20 arcs, and 220 32-C.P. for street lighting. 1,960 8-C.P. for private lighting. Price per unit, average, 7½d. (sliding scale); gas, 4s. Engineer, H. B. Price, Arc Works, Chelmsford.

COWPEN QUAY.—Sanderson & Co. Brush arc lamps in series. Babcock boiler, Chandler engine. Overhead wires with fluid insulation. 19 arcs of 2,000 C.P., used for harbour lighting. No return since last year. Engineer, R. S. Mylton.

CRYSTAL PALACE.—Crystal Palace District Electric Supply Company. High tension system with motor generators in sub-stations. Hornsby engines and boilers (5 of each), 7 batteries of accumulators in sub-stations. 4,000 incandescent and 12 arcs used for private lighting. Capacity of stations, 30,000 8-C.P. lamps. Price per unit, 8d; gas, 2s. 9d. Total outlay, £64,000. Resident engineer, P. J. Rea.

DERBY.—Corporation. Alternating current sub-station system with ring main secondary for private supply, constant current arc for street lighting. Siemens alternators and arc lighters coupled direct to Browett and Lindley engines. Underground armoured feeder mains, vulcanised mains for distributing, 1,700 8-C.P. and 8 arc lamps for private lighting, 30 arcs for streets. Capacity of station, 7,500 lamps of 8 C.P. Price per unit, 6d.; gas, 2s. 11d. Engineer in charge, J. E. Stewart.

DUBLIN.—Corporation. High tension alternating (2,000 v.), with house transformers, for private supply; 3,000 v. arc circuits for public lighting. 4 Babcock boilers, 3 compound engines of 350 H.P. each, and 1 of 100 H.P. for private supply; 3 compound engines of 60 H.P. each, for public lighting. Lowrie-Hall alternators, Brush arc machines, Silvertown cable in underground pipes. 81 500-watt arc lamps for streets; 21 arcs, 13,500 8-C.P. incandescent, for houses. 7,000 8-C.P. lamps have been added during the past year. Price per unit. 7d., less 5 per cent.; gas, 3s. 4d. The efficiency of dynamo and engine is 87 per cent. The cost of coal per unit is 1·09d. at 16s. per ton. The station cost £31,000. Engineer, Mark Ruddle, Central Station, Dublin.

DUNDEE.—Corporation. L.T. 3-wire system with accumulators. 3 Lancashire boilers, 6 Willans engines, and 6 continuous current dynamos by Siemens. A battery of accumulators with an output of 350 as for one hour. 25 arcs and 9,000 incandescents connected for private supply. Engineer, W. H. Brownlee, Electric Lighting Station, Dudhope, Crescent Road, Dundee.

EASTBOURNE.—Eastbourne Electric Light Company. H.T., alternating system, with house transformers; series system for arc lighting. Fowler's engines and boilers; total engine H.P. 400. Lowrie-Parker alternators. Underground main; insulated cables drawn into cast-iron pipes. 26 arc lamps, used for street lighting; 8,400 8-C.P. lamps for private lighting. Price per unit, 9d.; gas, 3s. 2d. Engineer, H. W. Wilkinson, Central Station, Eastbourne.

EXETER.—Exeter Electric Light Company. H.T. alternating and H.T. series arc. Two compound horizontal, non-condensing engines, 120 H.P. each, by Fowler, and two Westinghouse triple expansion engines of 25 H.P. Underground mains, Fowler-Waring concentric cable. 32 arcs and 5,000 8-C.P. for private lighting. Capacity of station, 6,600 8-C.P., and 60 arc lamps; 1,000 lamps added during the past year. Price per unit. 6d.; price of gas, 3s. 1d. Cost of station, £16,000. Engineer, H. D. Munro, Rockfield Works, Exeter.

FAREHAM.—Farcham Electric Light Company. Thomson-Houston system. Ransomes, Sims & Co. compound engines. Overhead and underground mains. 20 arcs and 90 incandescent lamps for street lighting, and 320 16-C.P. incandescent lamps for private lighting. Price to consumers 1s. per C.P. per annum and 8d. per unit; gas 3s. 9d. Station, with mains, cost originally £5,000. No return since last year.

GALWAY.—Galway Electric Light Company. Low tension system. Crompton and Statter dynamos; 2 Hercules turbines. 7 arcs and 4 incandescents for docks; 1,700 8-C.P. incandescent for private lighting. 700 incandescents added during past year. Price per unit, 5d.; for power, 3d. gas, 5s. 9d. Engineer, J. E. Pearce.

GLASGOW.—Corporation. L.T. three-wire system, with accumulators for private lighting. 3,000 v. arc machines for street lighting. L. Clark-Muirhead dynamos and Willans engines. Boilers by Lindsay, Burnett & Co. Brush machines and Easton-Anderson engines for street lighting. Arc light mains are of rubber insulation drawn into iron pipes. L.T. network copper strip in C.I. culverts. About 80 arc lamps have been erected in the streets. 30,000 8-C.P. incandescent lamps for private lighting. Capacity of station, 45,000 8-C.P. lamps. Price per unit, 7d. Cost of system including the taking over of Mavor & Coulson stations, £60,000. Engineer-in-Chief, W. Arnot.

GLASGOW.—Kelvinside Electric Light Co. L.T. three-wire system, with accumulators. Babcock boilers, 2 Willans engines and Goolden dynamos direct coupled. Underground mains, Callender's covered and armoured type. Price per unit, 8d.

HALIFAX.—Corporation. High tension alternating system. Compound horizontal engines. Underground mains, vulcanised in iron pipes. Capacity of station, when completed, will be 8,000 8-C.P. Price of gas, 2s. 2d. Station being erected. Electrical Engineer, T. P. Wilmshurst.

HALIFAX.—Halifax Mutual Electric Light and Power Supply Co. This company is in liquidation, but the station was running until a few weeks ago, when it was burnt down.

HANLEY.—Corporation. H.T. alternating current with transformers at sub-stations. 3 boilers, 2 com. vertical engines, 200 H.P. each, 2 of 100 H.P. each, 2 engines and dynamos (continuous current) for street lighting. 30 arc lamps and 40 incandescent for street lighting. Underground mains, primary concentric in cast-iron pipes. Low pressure in cast-iron trough filled up with bitumen. The capacity of the station, when completed, will be 10,000 lamps of 8 C.P. Price per unit, 6d.; gas costs 2s. 9d. Station being erected under the superintendence of Mr. J. Lobley, Borough Engineer. Engineer in charge, G. H. Cottam, Corporation Electrical Engineer.

HARROGATE.—Corporation. H.T. alternating current system, L.T. network, and H.T. system with house transformers. Steam will be generated from town's refuse; 1 Lancashire boiler as a stand-by in case of breakdown. 2 Parsons turbines; surface condensers. Underground concentric mains. A little street lighting is to be done. The installation is in progress of erection; it is expected to cost £15,000. Consulting engineer, Geo. Wilkinson, M.I.E.E.

HASTINGS.—Hastings and St. Leonards Electric Light Company, Limited. H.T. alternating current with transformers. Brush engines and alternators. Underground mains. 4,000 8-C.P. in use. Price per unit, 9d., gas 3s. 9d. No return since last year.

HUDDERSFIELD.—Corporation. H.T. alternating current with transformers, Mordey-Victoria alternators, Brush engines and Babcock boilers. High tension mains are concentric, insulated with vul. I.R.; low tension mains are bitumen covered. Only 3 arc lamps at present for street lighting, 7,500 8-C.P. incandescent for private lighting. Capacity of station, 10,000 8-C.P. lamps. Price per unit, 6d.; gas, 2s. 9d. Efficiency of dynamo and engine 75 per cent. Coke is used costing 6s. per ton. Fuel burnt per unit is 15 lbs. of coke, which includes banking fires, &c. Cost of station, when completed, £37,000; mains and transformers, £14,000. Borough Electrical Engineer, A. B. Mountain.

HULL.—Corporation. L.T. three-wire system, with accumulators. Willans engines combined with Siemens dynamos. Underground mains, Crompton bare copper strip and on Callender-Webber system. 3,000 8-C.P. incandescent and 40 arcs, used for private lighting. Capacity of station, 9,000 8-C.P. Price per unit, 7d.; gas, 2s. 6d. Cost of station and mains, £35,000. Borough Electrical Engineer, A. H. Gibbings, Dagger Lane, Hull.

KENSINGTON.—Kensington and Knightsbridge Electric Light Company, Limited. L.T. 3-wire system, with secondary batteries. Babcock boilers, 2,180 H.P., Willans engines, 2,120 H.P. Siemens and Crompton dynamos. Underground mains, copper strip in culvert, and Henley's cable in iron pipes. 63,000 8-C.P. connected for private lighting. 16,961 8-C.P. incandescent added during the past 12 months. Capacity of station, 43,580, 30-watt lamps on at one time (without batteries). Price per unit, 8d. Engineer-in-Chief, R. E. Crompton, "Thriplands," Kensington Court, W.

KESWICK.—Keswick Electric Lighting Company. H.T. alternating transformer system. Victor turbines, 50 H.P., and the Westinghouse engine, 60 H.P. Kapp alternator. Overhead wires on Johnson & Phillips fluid insulator. 1 arc lamp and 1,048 incandescent lamps for private supply. Capacity of station, 2,000 8-C.P. lamps. Price to consumers is by contracts based on gas bills; gas, 3s. 3d. per C.P. per annum. Engineer, J. R. Dixon, Stanley Terrrce, Blencathra Road, St. Keswick.

KILLARNEY (IRELAND).—Lighting done by company. H.T. alternating current with sub-stations (2,000 v.) Underground vulcanised rubber cables. Turbine, 70 H.P. About 500 8-C.P. incandescent lamps for private lighting. Capacity of station, 2,000 8-C.P. Price per unit, 6d.; gas, 5s. Engineer, Victor M'Cowen, Killarney.

KINGSTON-UPON-THAMES.—Corporation. High tension alternating (2,000 v.), with transformer sub-stations. Belliss engines and boilers, Siemens dynamos. Underground mains, Siemens concentric armoured cable. 36 arc lamps, used for streets; 10 arcs and 2,500 incandescents, for private supply. Capacity of station, 5,000 8-C.P. Coal, 11s. 6d. per ton Cost of station about £18,000; mains, £3,500. Engineer, J. E. Edgcome. Electric light station, Kingston-upon-Thames.

LANCASTER.—Corporation. L.T., 3-wire system. 2 Lanc. boilers, 3 Willans compound engines. Underground mains on Callender-Webber system. Capacity of station, 4,000 16-C.P. Price per unit, 7d.; gas, 2s. 6d. Station not yet completed, but expected to be at the beginning of 1894. Engineer, A. S. Barnard, Town Hall, Lancaster.

LARNE (CO. ANTRIM).—J. E. H. Gordon & Co. (in liquidation). High tension alternating system with sub-station transformers and street transformers. 2 25-k.w. Mordey alternators (2,000 v.). 2 Penman boilers. High tension mains (British insulated concentric) are placed underground; part of low tension network overhead supplied from transformers on poles. Streets lighted by 11 arc lamps and 56 incandescents. About 400 8-C.P. lamps for house lighting. Capacity of station about 1,500 8 C.P. Price per unit, 6d., though much of the lighting is done on a contract of 10s. per lamp per annum; gas, 4s. 7d. Resident engineer. Archer Turner.

LEEDS.—Yorkshire House-to-House Company. High tension alternating with house transformers. Lanc. boilers, Fowler engines (total I.H.P., 700), Lowrie-Hall alternators. Underground mains, Silvertown cables in cast-iron pipes. Private supply consists of about 10,300 8-C.P. Station working up to its full capacity. Price per unit, from 8d. downwards, according to quantity consumed; gas, 2s. 2d. Efficiency of dynamo and engine, 70 per cent. Cost of station, £43,000. Resident engineer, H. Dickinson.

LIVERPOOL.—Liverpool Electric Supply Company. Low tension direct, partly two-wire and partly three-wire. Lanc. boilers, Willans engines (3,800 I.H.P.). Siemens and Crompton dynamos. Underground mains on Callender system. 80 arc lamps and 23,500 16-C.P. lamps, 6,000 16-C.P. added during the past year. Capacity of station, 30,000 16-C.P. lamps. Price per unit, 7½d.; gas 3s. Engineer-in-Chief, A. Bromley Holmes, 15, Highfield Street, Liverpool.

LONDONDERRY.—Corporation. H.T. continuous current system. Lancashire boilers of 400 H.P., 3 compound condensing vertical engines and 6 dynamos. Underground mains, armoured cables. Street lighting only at present, there being 160 arc lamps. Capacity of station, 220 arc lamps (10 ampères). Private lighting is under consideration, and will be proceeded with shortly. Station not completed. Engineer, H. W. Blake, 35, Shipquay Street, Londonderry.

LONDON DISTRICTS:—

BELGRAVIA and PIMLICO.—Westminster Electric Supply Corporation, Eccleston Place Station. L.T. system, generated at 200 v. and distribution in two parallels of 100 volts each. Willans and Davey-Paxman engines. Davey-Paxman "Economic" boilers, and Fraser of same kind. Total I.H.P., 760. Crompton and Siemens dynamos. Underground mains, bare copper in culverts, and insulated cable in Callender conduit. Engineer-in-Chief, Prof. A. B. W. Kennedy.

MAYFAIR.—Westminster Electric Supply Corporation, Davies Street Station. Same system as at Eccleston Place. Willans engines Paxman and Fraser boilers. Crompton and Elwell-Parker dynamos. Same system of mains as other stations. Engineer-in-Chief, Prof. A. B. W. Kennedy.

WESTMINSTER.—Westminster Electric Supply Corporation, Millbank Street station. Same system as other stations belonging to this company. Willans engines, Babcock boilers. Total lamp connections for the three stations of this company amount to 130,000 32-watt lamps, about 31,000 lamps have been added this year. Engineer-in-Chief, Prof. A. B. W. Kennedy.

CHELSEA.—Chelsea Electricity Supply Company, Limited. System, generation of current at 200 and distribution in two parallels of 100 v. each. Battery in parallel with 200-volt dynamos. Crompton and Siemens dynamos, Willans engines, and Babcock boilers. Underground mains on Callender-Webber system. 40 arcs and 39,000 incandescent lamps for private lighting, 9,000 lamps added during the past year. Capacity of station, 40,000 8-C.P. lamps. Price per unit, 8d. with rebates; gas 3s. 1d. Efficiency of dynamos and engines, 80 per cent. Revenue per 8 C.P. lamp, 8s. 6d. Engineer-in-Chief, Frank King, 4, Great Winchester Street, E.C.

Abbreviations:—H.T., high tension; L

IST OF

STATIONS OF GREAT BRITAIN.

LONDON DISTRICTS.—*Continued.*

CITY OF LONDON.—City of London Electric Light Company and District of St. Saviours. H.T. alternating system with transformer sub-stations, and L.T. three-wire network. Two central stations, nearly completed, in which are Brush engines, Mordey-Victoria, Thomson-Houston alternating and arc machines. Underground cables on Callender and other systems. 505 arcs and 900 glow lamps for streets, and about 61,000 8-C.P. lamps for house lighting. Capacity of station, 100,000 8-C.P. lamps. Twenty-two transformer stations have been constructed. Price per unit, 8d. Estimated cost about £1,200,000. Engineer-in-Chief, David Cook, 1 and 2, Great Winchester Street, E.C.

LONDON.—London Electric Supply Corporation. H.T. alternating (10,000 v.) with transformer sub-stations. Hick, Hargreaves engines and Ferranti alternators. Underground concentric mains. About 65,000 16-C.P. lamps connected. Engineer-in-Chief, P. Walter d'Alton.

NOTTING HILL.—Notting Hill Electric Lighting Company. L.T. direct current system. Babcock and Wilcox boilers, Willans engines, two of 200 and two of 100 H.P., and Crompton dynamos. Underground mains on three-wire system. 12,000 incandescent lamps used for street lighting. Capacity of station returned as 24,000 8-C.P. Price per unit, 8d., subject to discount. The revenue per lamp is about 8s. Engineer-in-Chief, George Schultz, Bulmer Place, Notting Hill Gate.

ST. MARTIN'S-IN-THE FIELDS.—Charing Cross and Strand Electricity Supply Corporation, Limited. L.T. direct current system. Babcock boilers, Willans engines, and Mather and Platt dynamos. Underground mains on Callender system. 15 arc lamps, and 32,000 8-C.P. incandescents used for private lighting. 3,000 lamps added during the past 12 months. Price per unit is 6d. reducible to 5d. Engineer-in-Chief, W. H. Patchell, 12. Maiden Lane, W.C.

ST. MARY ABBOTS, KENSINGTON.—House-to-House Electric Supply Company, Limited. Alternating current system with house transformers. 5 compound horizontal Fowler engines each of 200 I.H.P., and 1 of 100 H.P.; 4 Babcock and 1 Lanc. boilers. Lowrie-Hall dynamos. 27,100 8-C.P. incandescent lamps and 12 arcs connected, 3,400 lamps have been added during the past 12 months. The present capacity of the station is 44,000 8-C.P. The annual revenue per 8 C.P. lamp is 9s. Engineer, H. W. Bowden, Richmond Road, Brompton, S.W.

ST. JAMES'S PARISH.—St. James's and Pall Mall Electric Lighting Company, Limited. L.T. three-wire. Two stations, in which are Davey-Paxman boilers, Willans engines, and dynamos by Siemens and Latimer Clark, Muirhead. Underground mains, bare copper strip, and armoured cables. 48 arcs and 55,732 8-C.P. lamps for private supply. 10,940 8-C.P. added during the past year. Capacity of station, 63,940 8-C.P. lamps. Price per unit, 6d., with rebate; gas, 3s. 1d. Engineer-in-Chief, S. T. Dobson, Carnaby Street Station, Golden Square, W.

ST. PANCRAS PARISH.—Vestry. L.T. continuous three-wire system and accumulators. Babcock boilers, Willans engines and Kapp multipolar dynamos. Underground mains, bare copper strip in culvert. 95 arcs for street lighting; 108 arcs and 12,493 incandescent lamps of 16 C.P., and 19 motors of 46½ I.H.P. used for private lighting. The following additions have been made during the past year: 2,563 16-C.P., 26 arc lamps and 7 motors. Present capacity of station, 13,000 16-C.P. Price per unit, 6d., 3d. for "day" supply: gas 3s. 1d Cost of station, £46,103 (including £10,000 for land). Mains, £33,787. The plant at Stanhope Street station is being increased by three boilers, and three engines and dynamos. A new battery sub-station is being erected in Regent's Park Road, and the erection of a new central station in combination with refuse destructor is about to be commenced. Resident Engineer, J. T. Baron, Stanhope Street, N.W

STRAND DISTRICT. ST. MARTIN'S, HOLBORN, MARYLEBONE, PADDINGTON.—Metropolitan Electricity Supply Company, Limited. H.T. alternating transformer system and low pressure continuous system. There are five stations, at the following places: Manchester Square, Sardinia Street, Rathbone Place, Amberly Road, Paddington, and at Whitehall Avenue. Babcock and Wilcox boilers; engines by Westinghouse, Willans, Hornsby, Allen, and Hick Hargreaves; dynamos by Electric Construction, Westinghouse, Kapp, Siemens, and Latimer Clark, Muirhead & Co. Private lighting is equivalent to 160,000 8-C.P. Price per unit, 7½d., with sliding scale to 5½d. Engineer-in-Chief, Frank Bailey, 17, South Street, Manchester Square, W.

LYNTON.—Hans H. Benn. H.T. alternating current system. Water power; C. L. Hett's turbine and Mordey alternator. 37 32-C.P. lamps for street lighting, 1,200 8-C.P. incandescents in use for private lighting.

MANCHESTER.—Corporation. L.T. 5-wire system. 6 Lancashire boilers, 4 large vertical com. engines, 6 small vertical com. engines. Dynamos by Electric Construction Corporation and Mather & Platt. Underground mains, concrete culverts with bare copper mains, iron pipes with insulated cables. No street lighting. 204 arc lamps, 28,000 8-C.P. lamps, and motors aggregating 61½ H.P. Station has been running only five months. Corporation Electrical Engineer, Herbert Wooler, 8, Claremont Road, Alexandra Park, Manchester, and Corporation Works, Dickinson Street, Manchester. Consulting Engineer, Dr. John Hopkinson.

MORECAMBE.—Morecambe Electric Light and Power Company, Limited. L.T. two-wire system. Gas engines; 3 Stockport 40 I.H.P., 1 Crossley 60 I.H.P., and 1 Crossley of 150 I.H.P., these are supplied by Dowson gas apparatus. About 50 arc lamps, and 2,500 incandescent lamps used in private supply; 35 arcs and 1,300 incandescents have been added during the past year. Capacity of station is about 5,000 8-C.P. Price per unit, 7d., or by contract at 10s. per annum per 8-C.P.; gas 3s. 11d. per 1,000 feet. Cost of coal per unit generated, '39d.; price of coal (anthracite) per ton, 22s. 8d. Cost of station about £5,300; mains about £2,000. Engineers, Messrs. Andrews & Preece, Borough Mills, Bradford.

NELSON.—Corporation. L.T. two-wire system. 2 Willans engines, Lancashire boilers. Mains are laid underground in cast-iron conduits. 4 arc lamps for street lighting, and about 1,000 16-C.P. incandescents for private lighting. Capacity of station 2,000 16-C.P. lamps. Price per unit, 5d.; gas 2s. 6d. per 1,000 feet. Cost of station about £7,500; mains £3,000. Waste heat from gas retort furnaces used for boilers. Station has been working only 9 months. Engineer, John Foster, Engineer's Office, Gas Works, Nelson.

NEWCASTLE.—Newcastle and District Electric Lighting Company, Limited. H.T. alternating current system. Lancashire boilers and Parsons turbo-electric generators, 700-unit plant. Underground mains. 9 arc lamps for street lighting, 60 arcs and 18,000 10-C.P. incandescents. 4,000 lamps added during past 12 months. Capacity of station 20,000 lamps of 10-C.P. Price per unit, 6d., less discount, varying from 5 to 25 per cent. Engineer, W. D. Hunter, 38, Granger Street West, Newcastle.

NEWCASTLE.—Newcastle Electric Supply Company. H.T. alternating current with transformers. Lancashire boilers, horizontal compound engines, underground concentric cables. About 21,000 30-watt lamps used for private lighting; 2,200 lamps added during the past twelve months Price per unit, 4½d. with discounts; gas 1s. 10d., less 10 per cent. Engineer, R. C. Jackson, Pandon Dene, Newcastle-on-Tyne.

NORTHAMPTON.—Northampton Electric Light and Power Company, Limited. L.T. direct current. 3 Daniel Adamson Lancashire boilers, 3 Scott & Hodgson's vertical compound engines, each of I.H.P., and Crompton dynamos. Crompton system of underground mains. 12 arcs and 4,500 incandescent used for private lighting. Price per unit, 8d.; gas 2s. 7d. per 1,000. Revenue per 8-C.P. lamp, 7s. Engineer, W. G. Heeman, Electric Light Station, Northampton.

NORWICH.—Norwich Electricity Company. L.T. continuous current three-wire system. 3 Willans engines, 100 H.P. each. 2 Babcock-Wilcox boilers, 140 H.P. each. Underground mains, bare copper, about 2,000 yards laid in culverts, the rest in earthenware pipes on Scott system. Maximum output of station, 1,100 ampères. Capacity of station in lamps, 3,000 16-C.P. Price per unit, 8d. for a period of day between an hour after sunset and 8 p.m., rest of day 4d. per unit. Engineer, F. M. Long, Duke Street, Norwich.

NOTTINGHAM. — Corporation. L.T. 3-wire system. Willans engines, Lancashire boilers. Underground mains on Callender-Webber system. Plant is being put down for 10,000 8-C.P. lamps in use at one time Price of gas, 2s. 6d. Engineer, H. Talbot, 19, Addison Villas, Nottingham.

OXFORD.—Oxford Electric Light Company.—H.T. continuous current with motor-generator transformers. Three triple expansion engines, surface condensing, marine type of 200 H.P. each, 3 loco. boilers (Mc Laren) of 200 H.P. each; dynamos by Electric Construction Corporation. Underground mains, H.T., Silvertown, L.T., Callender's lead covered. Sixteen arcs used for street lighting, 7,000 8-C.P. for private lighting, 3,000 8-C.P. added during the past year. Capacity of station, 15,000 8-C.P. Price per unit, 8d., with 5 per cent. discount on accounts paid within the month; gas 3s. 4d. per 1,000. Coal consumption per hour per unit, 4·2 lbs. Engineer, J. Hardie McLean, 45, Broad Street, Oxford.

PORTSMOUTH.—Corporation. H.T. alternating (2,000 volts). Lancashire boilers. Underground mains on Johnstone's patent subway system. Street lighting will commence with 101 arc lights, and 2 32-C.P. incandescent lamps on each pillar, these to be turned on at midnight. 8,000 16-C.P. for house lighting. Price per unit, 6d.; gas, 2s. 3d. The station, which will be opened about beginning of next year, will cost £58,000.

PRESTON.—National Electric Light Company. L.T. 3-wire system. Belliss direct coupled engines, 2 of 55 H.P., and 6 of 100 H.P., 5 Lancashire multitubular boilers of 250 H.P. each, by Paxman & Co., dynamos by Latimer Clark, Muirhead & Co. Underground mains. 12 arcs and 26 32-C.P. incandescent lamps for street lighting, and 42 arcs and 7,500 8-C.P. lamps for private lighting. 4,000 8-C.P. added during the past 12 months. Present capacity of station 14,000 8-C.P. connected at once. Price per unit. 7d., less 15 per cent.; gas, 3s. 7½d., less 15 per cent. Revenue per 8-C.P. lamp, 10s. Land and buildings £6,416; machinery, &c., £14,103; mains, £21,313. Engineer, J. H. Tonge, 20, Baristow Street, Preston.

PRESCOT.—British Insulated Wire Company. H.T. alternating current system. Mordey alternators; Raworth, Browett, and Tangye engines. Underground mains on B.I.W. system. 12 2,000-C.P. arcs for street lighting, 1,000 12-C.P. for private lighting. Price per unit, 7d.; gas, 4s. 8d.

READING.—Laing, Wharton & Down Syndicate, Limited. Thomson-Houston system. Overhead wires. 2 50-H.P. engines, and 3 25-H.P. engines. 90 arc lamps, and 1,400 8-C.P. incandescent lamps used for private lighting. Price per unit, 8d., arc lamps by contract. Station fully loaded. Engineer, F. F. Yeatman, Electric Light Depôt, Reading.

SCARBOROUGH.—Scarborough Electric Light Company, Limited. H.T. alternating (2,000 v.) system, with sub-stations in part of the town. 2 Lanc. boilers, 2 150-kilowatt Parsons steam turbine alternators and exciters. 13 arcs and 4,181 8-C.P. incandescent lamps for houses. Underground mains consisting of India-rubber non-concentric cables drawn into cast-iron pipes. Capacity of station, 10,000 8-C.P. lamps. Price per unit, 6¾d. to 5¼d. according to consumption; gas 2s. 9d. Managing director and engineer-in-chief, A. A. C. Swinton, 66, Victoria Street, Westminster. Resident Engineer, G. S. Peck, 102, Westborough, Scarborough.

SHEFFIELD.—Sheffield Electric Light and Power Company, Limited. H.T. alternating system with transformer sub-stations. 5 engines, 650 H.P., 5 boilers, 1,500 H.P. 140 arc lamps and 7,000 8-C.P. lamps. Present capacity of station, 9,500 8-C.P. and 150 arc lamps. Price per unit, 6d., price of gas, 2s. and 2s. 3d. The entire system has been reconstructed during the past 12 months and is not yet completed. Engineer, Wm. Johnson.

SOUTHAMPTON.—Southampton Electric Light Company. L.T. three-wire system, with accumulators. 2 Willans engines direct driving and one 120-I.H.P. Robey compound belt driving Crompton dynamos. Underground mains on Crompton system. 38 arcs of various powers and 2,500 8-C.P. incandescent; current is also supplied to two electric cranes at the Harbour. About 600 lamps have been added during the past twelve months. Capacity of station about 4,000 lamps, with all the plant in use, but engine of 60-H.P. is reserved for supplying power to the cranes. Price per unit, 8d., with sliding scale; gas, 2s. 8d. The efficiency of engines and dynamo direct driven is 80 per cent., and about 55 per cent. with belt driven. Coal consumption per kilowatt hour is 17 lbs., coal cost 15s. 4d. per ton. Cost of station and mains, £14,000. Engineer, J. H. Lee, Electric Light Station, back of the Walls, Southampton.

SOUTHPORT.—Corporation. H.T. alternating (2,000 v.) system, with sub-stations. 2 Lancashire boilers, 3 engines and dynamos, rope driven, of 250 kilowatts capacity. Underground mains, concentric armoured cables. The boilers are constructed for burning coke breeze from the Corporation Gas Works. Cost per unit, 6d.; gas, 3s. 3d. Station in course of construction. Will cost from £18,000 to £20,000. Consulting Engineer, G. Wilkinson.

ST. AUSTELL.—Veale & Co. L.T. system. Compound engines of 70 H.P. Underground mains. Capacity of station, 1,300 16-C.P. Several motors are used for printing, grinding, stone-masons' work, &c. No return since last year. Engineer, J. M. Coon.

TAUNTON.—Corporation. H.T., alternating current system (Thomson-Houston) for private lighting, and Thomson-Houston series arc lamps. Babcock and Davey-Paxman boilers. 2 Willans engines, indicating 120 H.P. each; 2 Ruston, Proctor & Co.'s, indicating 75 H.P.; one Bumsted-Chandler, indicating 50 H.P.; 2 Thomson-Houston alternators of 70 units each; and one Thomson-Houston of 25 units. 4 T.H. arc lighters of 30 lights each, and one 10½-unit Elwell-Parker dynamo. There are 36 public and 40 private arc lamps and 2,200 8-C.P. incandescent lamps installed. Mains are at present overhead, but will shortly be placed underground. Price per unit, 6d.; gas, 3s. 9d. Price of coal is 16s. 6d. Managing Electric Engineer, Harold W. Couzens, St. James Street, Taunton.

THETFORD.—Thetford Electric Light Company. L.T. system. 2 50-H.P. boilers, 1 60-H.P. engine, 1 30-H.P. engine. Lawrence-Scott dynamos. Overhead wires. 70 arc lamps and 1,000 8-C.P. lamps. 70 arc lamps, 100 incandescent and several motors have been added during the past twelve months. Capacity of station 1,800 8-C.P. lamps. Price per unit, 7d., price of gas, 5s. Consumption of coal per kilowatt hour, 7 lbs. Total cost of constructing and equipping central station, £3,000. Engineer, R. Carter.

WATERFORD.—Waterford Electric Light Company. Post authorities say that this company has gone away.

WEYBRIDGE.—Electric Light Company. Thomson Houston system. Two 75-H.P. compound engines, and one 100-H.P. boiler. 500 16-C.P. lamps in use. Overhead wires. No return this year.

WHITEHAVEN.—Corporation. L.T. two-wire system for street lighting, and low tension three-wire for private lighting. Two Lancashire boilers, total H.P., 500. Four Willans engines and Crompton dynamos, total H.P., 210. Underground mains by Siemens. The streets and harbour lighted by 498 incandescent lamps of 8 to 64 C.P. About 1,000 16-C.P. incandescents for private lighting. Capacity of station, 2,300 16-C.P. Price of current, fixed charge of 30s. per year, and 2d. per unit consumed; gas 3s. 6d. per 1,000 feet. Works not yet completed. Consulting Engineer, Dr. John Hopkinson, 5, Victoria Street.

WICKWAR.—A company. Low tension, two-wire system. 1 Davey-Paxman 60 I.H.P., Adlam's 15 I.H.P., and one over-shot water wheel. Elwell-Parker dynamos. Overhead wires. 20 incandescent lamps of 32-C.P. 330 incandescent lamps, almost all used by the owners of the installation. This installation is really a private one, but the owners have run a circuit by special request of the inhabitants to light the principal thoroughfare. Engineer, F. G. Ansell, Wickwar, Glos.

WOKING.—A company. H.T., alternating current system. No other particulars obtainable.

WOLVERHAMPTON.—Corporation. H.T., direct (2,000 volts), with motor transformers. 3 Lancashire boilers, 2 250-I.H.P. Marshall horizontal compound condensing, one of 125 by same makers; dynamos by Electric Construction Corporation. Underground mains; armoured cables for distribution, armoured concentrics for arc lamps, and Callender solid for H.T. feeders. 40 arc lamps to be used for street lighting. Capacity of station 6,000 8-C.P. actual. Price per unit, 6d.; gas, 3s. Station will probably cost £24,000, mains £5,700. Contracts were not issued for this station at the end of last month. Borough Electrical Engineer, F. Harman Lewis, Town Hall, Wolverhampton.

WOOLWICH.—Woolwich District Electric Light Company, Limited. H.T. alternating transformer system. Chandler high-speed engines. Underground mains in cast-iron pipes. 1,100 35-watt incandescent lamps used for private lighting. Capacity of station, 1,250 lamps. Price per unit, 7d., gas 2s. 5d. Cost of station £6,000. Engineer, G. E. B. Pritchett, 31, Soho Square, W.

The electric light has advanced beyond the enquiry stage in the following towns, but the work has not sufficiently progressed to justify us placing them in the foregoing list:—

AYR.—Corporation considering the matter.

BIRKENHEAD.—Considering the matter.

BROMLEY.—Nothing decided.

BURNLEY.—Works in progress.

BURTON-ON-TRENT.—Corporation works in progress.

BURY.—System not yet decided upon.

CARDIFF.—Corporation station in course of construction.

CRIEFF.—Corporation are considering the matter.

DEWSBURY.—Corporation station about to be erected.

DUDLEY.—Nothing decided.

EALING.—Corporation station in course of construction.

FALMOUTH.—No system decided upon.

GREAT YARMOUTH.—Corporation works will be probably started at the beginning of next year.

HAMPSTEAD.—Vestry electric light station in course of construction.

ISLINGTON.—Vestry electric light station in course of construction.

LLANDUDNO.—No system decided upon.

OLDHAM.—Works in progress.

RICHMOND.—Corporation works in progress.

SHOREDITCH.—The Vestry are considering a scheme.

SOUTH SHIELDS.—Corporation electrical engineer appointed to devise a system.

SUNDERLAND.—Corporation asked for tenders some weeks ago.

SWINDON.—Considering the matter.

TORQUAY.—Although all preliminaries were settled and experts' reports received, the matter has been adjourned for six months.

WORCESTER.—Corporation station in course of construction.

high tension; L.T., low tension.

capital text book for beginners, and a useful introduction to more advanced works on machine design. The appearance of such technical manuals as this is a healthy symptom of our recent awakening in the matter of technical education.

Standard Tables for Electric Wiremen, with Instructions for Linemen and Wiremen, Rules, Useful Formulæ, and Data. By. C. M. DAVIS. Revised by W. D. WEAVER. Fourth Edition. Published by the W. J. Johnson Company, New York.

This is an excellent little work of reference on all matters connected with wiring; the illustrations, the matter, the printing, paper and binding are all good and well selected for such a book. The price is its only drawback; it is published in New York at $1; considering that about 40 pages out of 128 are occupied by the American fire insurance rules and requirements, much of which is of no interest outside of America, this price is too much.

The tables are all accurate, and for the first time in any handbook, tables are given for the calculation of alternate current wiring, bringing the subject within the reach of practical men. This is an important subject, and well worth considering in valuing the book. Economy in wiring is an important consideration for installation fitters, so that a handy book of reference on the subject is a necessity.

Some calculations for horse-powers of engines and boilers are also included.

The work closes with 15 excellent little plates of diagrams of wiring systems—lamps, accumulators, dynamos and motors.

CORRESPONDENCE.

Duplex Nozzles.

A month or two since many of the technical journals, under the heading of "Duplex Nozzles," published certain disparaging statements as to the status of an old and tried friend, viz., the solid, simple, or central steam jet as applied to blowing purposes. As strong conservatives in this matter, we ask you to allow us to reply on the other side.

Sir Wm. Siemens was, we believe, one of the first to claim higher efficiency for the annular over the central or solid steam jet for blowing purposes. We had, however, supposed that no one in these days, who had given the subject any practical consideration, would now support the proposition. It should, however, be noticed, in the first place, that a nominally annular jet is not really so, unless the air, or whatever other fluid is to be propelled, is admitted into the annulus through the centre, as in the blowers designed by Sir Wm. Siemens. In the duplex nozzle referred to above, not only is no provision made for admitting air inside the annulus, but the annular jet itself acts as a shield to prevent access of air to the central or solid jet. This explains the advantage of the interrupted annulus of the duplex nozzle, the three or four jets in the ring allowing access of air to the central jet, as well as all round themselves.

We have made the subject of jet blowers a special study for the last 10 years, and with respect to the form of nozzle, have come to the definite conclusion that the central or solid jet is the most efficient for all ordinary purposes, and that any departure from this not only increases the first cost, and adds useless complications, but actually detracts from the efficiency.

Having these very decided opinions, we were rather surprised at the prominent position given in the technical press to the alleged advantages claimed for the duplex nozzle. To leave no room for doubt, we obtained one of the duplex nozzles (as well as the combining tube supplied with it), and conducted a series of tests with it, the results of which we give below. The nozzle has a central jet, $\frac{3}{32}$ inch diameter, and three jets in a ring surrounding the central jet, and having a variable opening, the full maximum area being equal to that of a solid jet, upwards of 7 millimetres in diameter.

The duplex nozzle was regulated so as to give the same effect as a solid central jet of 4 millimetres diameter, which is considerably larger than our average size. The size of nozzle, viz., 4 millimetres, was taken as a standard for comparison, as being the size of nozzle in the third type of blower referred to later on.

The position of the regulating screw in the duplex nozzle was found, after making several tests with various forms and sizes of combining tubes giving equal volumes of outlet air at equal pressures. The air pressures tested were $\frac{3}{8}$ths inch water column, which may be taken as a normal ashpit pressure, 1 inch water and 2 inches water.

To arrive at the proportional efficiency of the nozzles, an air receiver of a certain capacity was filled with cold dry air at 20 lbs. pressure above the atmosphere, and emptied first through the duplex nozzle with the regulator in the proper position, and then through the simple nozzle. This was repeated several times, and it was found that the duplex nozzle reduced the pressure from 30 lbs. to 5 lbs. in 25 seconds, whereas the simple nozzle giving the same effect required 45 seconds. In other words, the duplex nozzle to give equal effect required 80 per cent. more steam than the simple central nozzle.

We presume, however, that the efficiency of the nozzle as such is of secondary consideration, and that the really interesting question is as to the relative efficiency of the complete blowers. To ascertain this a series of experiments were made with the duplex nozzle and the combining tube supplied with it, with our own blowers of various sizes, and with a third form of blower which has recently been "in evidence." The air pressures tested with were as mentioned above, $\frac{3}{8}$ths inch, 1 inch, and 2 inches water column, the corresponding steam pressures being 16 lbs., 42 lbs., and 70 lbs. above the atmosphere.

The net result of the series of experiments is to show that to do a given quantity of work, where our blower required a unit weight of steam, say 1 lb., the duplex arrangement used between $2\frac{1}{2}$ lbs. and $3\frac{3}{4}$ lbs., and the third form of blower from 2 lbs. to $4\frac{3}{4}$ lbs.

As the question of forced or assisted draught is continuously coming more to the front, and as the steam jet offers the simplest, and for most purposes the best form of blower, we think the figures given above should be of interest to many of your readers.

Meldrum Bros.

Niagara.

Allow me to say a few words with reference to Prof. Forbes's criticism of the synchronising power exerted by my alternators. Put briefly, the experiment to which he alluded consisted in placing between two machines a resistance considerably more than was required to absorb the whole output of one of them. As, even under these circumstances, the machines did not actually break out of step I regarded the experiments as very satisfactory, and as affording a very strong proof of the powerful synchronising effort effected by the machines, and it was therefore with the greatest astonishment that I heard them referred to by Prof. Forbes as showing the contrary.

W. M. Mordey.

Definite Voltages for Electrolytic Separations.—A few months ago H. Frendenberg called attention to the unsatisfactory methods generally used in electrolytic separation, and particularly to the fact that there was no agreement as to the proper voltage at which any given separation ought to be effected. He has recently followed up this protest with a further paper in the *Zeits. Physikal Chem.*, 1893, xii., p. 97. Here he describes his work with the electrolytic separation of metals by the use of currents of definite pressures. For this purpose he classifies metals into three groups, namely: 1. Those which are not separable from their aqueous solutions by currents of moderate voltage, *e.g.*, metals of the alkalies and of the alkaline earths—aluminium and chromium. 2. Those which can be precipitated on the anode in the form of peroxides, viz., lead, manganese and thallium. 3. Those appearing in the metallic state on the cathode. The voltage has little influence on the separation of these three groups, but applies chiefly to the separation of members of the third group. Frendenberg deals in detail with the separation of these metals, stating the proper pressure of current suitable in each case, and finally argues that since the voltage and not the total electrical energy is to be measured, the use of the oxyhydrogen voltameter should be abandoned in favour of a suitable galvanometer.

NOTES.

Manchester Ship Canal.—We understand that the whole length of the Manchester Ship Canal, 35½ miles, is to be lighted at night by electricity.

Wolverhampton Electric Lighting.—A Local Government Board enquiry is to be held at the Town Hall, on January 4th, into the application by the Town Council to borrow £30,000 for purposes of electric lighting.

A New Clause.—A member of the St. James's Vestry has given notice to move that a condition prohibiting the carrying on of operations during the night and early hours of the morning be attached to all consents given by the Vestry to electric lighting and other companies for the carrying out of works involving a disturbance of the public streets.

The Rottingdean Electric Railway.—At a meeting of the Brighton Town Council, last week, the Works Committee reported, with reference to the Brighton and Rottingdean Railway, that Mr. Volk had had an interview with them, and that they had requested him to furnish them with full detail drawings showing the company's proposals. Subject to their previous approval, the committee recommended the Council to grant the company a license to construct the line on the foreshore in the borough, and to erect a station by the east side of the Paston Place groyne, upon the company agreeing to pay the Corporation a rent of £25 per annum.

Let Off Lightly.—Some time ago we commented upon an exceedingly unjust action of the General Electric Company, of New York, in removing advertisement signs of the Western Electric Company from electric light poles at the World's Fair Electricity Building during the quiet of the night. We stated that the Western Electric Company had commenced proceedings against the General Electric Company, claiming $10,000 damages. The matter has now been settled without a court trial, the plaintiffs accepting $800, of which amount $300 goes to reimburse them for their costs and the value of the signs; the other $500 being paid over to benefit an orphan asylum. A full apology has also been made to the plaintiffs by Lieut. Spencer. This is a very satisfactory termination to one of the meanest affairs that could possibly be perpetrated by a business house. The General Electric Company (New York), who have for some time been in very low water, are doubtless thankful enough to get off so easily. Had the matter come publicly into Court, they would, more likely than not, have had to pay rather heavily.

Lectures.—In our last issue, under lectures, we mentioned one delivered by Mr. Charles Rettie on "The Power of the Electric Motor in Reference to Railways in the Future." The author writes, giving us the following further details:—"I showed 84 slides, and they were mostly taken from photographs kindly given to me by the Thomson-Houston Company, of America and Paris, also Messrs. Mather & Platt. Six slides of the Liverpool Overhead Railway were lent by the Electric Construction Company, of Wolverhampton.

Before the North Staffordshire Institute of Mining and Mechanical Engineers, the other day, Mr. R. H. Wynne read a paper on "The Application of Mechanical Arrangements in Underground Operations."

In connection with the Belfast Natural History and Philosophical Society, a lecture was given last week in the Ulster Minor Hall by Mr. Wm. MacWhirter, M.I.E.E., M.Phil.Inst., Glagow. The subject dealt with was "Electrical Cooking and other Modern Electrical Inventions."

Some days ago a popular lecture was delivered by Mr. T. F. Horton before the St. Cuthbert's Mutual Improvement Union, at Bedford, the subject being "Modern Applications of Electricity."

"Heating Effects of the Electric Current" was the subject of the third of a course of lectures on electricity delivered by Mr. W. Cassie, M.A., in the Aberdeen Free Church College last week.

Mansion Lighting.—The Earl of Dartmouth is about to have the electric light introluced into his family mansion, Patshull House, near Wolverhampton.

The Tesla Engine.—Speaking at a meeting of the New York Electrical Society, Mr. Nikola Tesla referred to his improved engine, which is to do away with fly-wheels, cross-heads, and eccentrics; everything, in fact, but the piston and cylinder, all the control mechanism being electro-magnetic. Mr. Tesla's address is reported in the N.Y. *Electrical Review*, December 6th.

Obituary.—The lengthy litigation carried on in America some months ago between the owners of the Edison incandescent lamp patent and Mr. Henry Goebel, which excited a great deal of interest at the time, and was fully commented upon in these columns, must be still fresh in the minds of our readers. All possibility of any further proceedings being personally taken by Mr. Henry Goebel are now prevented by the death of that gentleman, which occurred at New York on December 4th, after a week's illness. He was 75 years of age.

We also regret having to record the death of Sir George Elliott, Bart., who was interested in the manufacture of telegraph cables. For some time he occupied the post of chairman of the Telegraph Construction and Maintenance Company. His death happened on Saturday last.

Hotel Lighting in America.—At a recent meeting of the Montreal Electric Club, Mr. John Smillie read a paper on an electric light plant of which he had charge in 1881, and gave a graphic description of the methods and electrical apparatus employed. This plant was one of the first in Canada, and was used for lighting the St. Lawrence Hall Hotel, in Montreal. It consisted of an arc and an incandescent dynamo of the old Maxim type, manufactured and installed by the United States Electric Lighting Company, of New York. The dynamos had Gramme ring armatures wound with double cotton-covered wire insulated from the armature core by paraffined paper. The commutator segments were originally insulated from each other by a press-board, which was rapidly burnt away by the sparking, and had to be renewed frequently. To remedy this, a noted electrician from the United States advised the substitution of asbestos paper. This, however, was not entirely satisfactory, for the reason that copper dust accumulated in the pores of the paper and caused short circuits between the segments. The incandescent dynamo supplied current to 65 16-C.P. Maxim lamps arranged in multiple. The lamps had carbonised paper filaments, and some of them had a life of 800 hours or over, but the greater number lasted only a few hours. One pole of the dynamo was connected with the main gas pipe in the building, and one terminal of each lamp was also connected with a gas pipe, so that no return wire was required. The circuit extended from the other pole of the dynamo to the lamps, and was composed of paraffined, cotton-covered, annunciator wire. One terminal of a lamp was connected with the wire, and the other grounded upon the nearest gas pipe. As a result, those who chanced to touch the pipes frequently received shocks. Short circuits between the wires and gas pipes were of common occurrence, and at times set fire to the paraffined covering of the wire. No fuses were employed on the installation. For the arc circuit bare copper wire was used, stapled directly to the walls and ceilings of the hotel. Where the wires crossed a gas or water pipe, pieces of rubber tubing were slipped over them to prevent contact with the pipe. On this circuit was a series of five Maxim arc lamps, for which Wallace carbons were used, at a cost of 10 cents each. Where the arc or incandescent circuits ran beneath floors, the boards above were left loose, so that they could be easily taken up to inspect the wires. The plant was run, on an average, about five hours a day, during which time it was necessary for the electrician to be continually on the watch to keep the apparatus in working order, and after it had stopped running for the day, considerable time was spent in overhauling the dynamos and wiring, and in making needful repairs. After being in operation about two years the plant was discarded, and the dynamos consigned to the scrap heap. The building was then re-wired, and current for lighting obtained from a local electric light station.

The Electrical Works of the Champ de Mars, Paris.—After the Exhibition of 1889, the Edison electrical works in the Champ de Mars were bought by the City of Paris, and they supply the electrical energy for the luminous fountains. Since that time it has been proposed, on several occasions, to use these works for the distribution of electrical energy in the neighbourhood, as the fountains only work a few times in the year. The Minister of Public Works has also been asked recently to use these works for lighting the Champ de Mars and the streets leading to it.

Coventry and its Consulting Engineer.—With reference to the suggested interest of Mr. Hammond in contracting work, Messrs. John Fowler have sent the following letter to the Mayor of Coventry:—

Dear Sir,—Our attention has been drawn to the report of your Council meeting in the *Coventry Times* of December 6th, from which we observe there is an erroneous impression in the minds of some of your members as to the connection of your consulting engineer, Mr. Hammond, with our company. The simple explanation of our connection with this gentleman is this: we have done business with Mr. Hammond for the past twenty years, and since the year 1878 have, in the ordinary way of business, supplied to his orders engines for electric light installations in all parts of the world. Mr. Hammond was, we believe, the pioneer of the house-to-house system of supplying light from a central station, which, after considerable opposition, is now accepted as the most economical method of distributing light. In many of the pioneer stations we were fortunate in securing the orders for the mechanical portions of the plant, and in several instances Messrs. Hammond & Co. supplied the electrical part. It was found in practice that when the orders for the various sections of the central station were placed in the hands of several contractors, it was impossible to distinguish where the responsibility of each contractor commenced and where it ended, which frequently resulted in serious complications. To overcome this difficulty, we arranged with the firm of Messrs. Hammond & Co., on several occasions, to send in a joint tender for the whole plant, which arrangement worked well. With the development of central station work, the demand upon Mr. Hammond's services as electrical engineer increased to such an extent, that he relinquished contracting work altogether, and confined himself entirely to consulting engineering. Having, as before stated, previously experienced the great inconvenience of not being able to undertake the complete equipment of central works, we some time ago engaged a special electrical staff and put down the most modern plant for the manufacture of dynamos, transformers, switchboards, and every kind of electric appliance required in central and private installations. Mr. Hammond is not now, and never has been, a shareholder in our company, and he has not, and never has had, any pecuniary interest in it. We should be very sorry if our long business connection with Mr. Hammond should in any way interfere with his business as a consulting electrical engineer, and we shall feel obliged if you will kindly read this letter at your next council meeting, and so clear up a wrong impression which evidently exists in the minds of some of your members as to Mr. Hammond's connection with our company.

Thanking you in anticipation, we remain, dear Sir, yours truly,

R. W. FOWLER, for
JOHN FOWLER & Co, Leeds.

No fault whatever can be found with the foregoing letter, but it will be interesting to give the latest return of the Leeds and London Electrical Engineering Company, Limited. This return was made in January of this year, and it is only fair to say that the next statement filed at Somerset House may put a different complexion on affairs.

Leeds and London Electrical Engineering Company, Limited (32,497). *Registered October 2nd*, 1890.

The latest return was filed on January 2nd last. The nominal capital is £100,000, divided into 250 founders', 9,750 preference, and 10,000 ordinary shares, all of £5 each. Out of these 992 shares have been taken up. The full amount has been called on 250 founders' 634 preference, and 8 ordinary shares, and £1 has been called on each of 100 preference shares. The total amount received is given at £4,530, and £30 is outstanding. The list of shareholders follows.

Founders' shares.	Shares.
Robert Henry Fowler, 6, Lombard Street, E.C., engineer ...	50
Alfred Fowler, 6, Lombard Street, E.C., engineer	75
Robert Hammond, 117, Bishopsgate Street Within, E.C., electrical engineer	125
Preference shares.	
Robert Henry Fowler, 6, Lombard Street, E.C., engineer ...	150
Alfred Fowler, 6, Lombard Street, E.C., engineer	25
Robert Hammond, 117, Bishopsgate Street Within, E.C., electrical engineer ... ... (100 transferred on April 25th, 1892.)	259
William Page, Waverley Grove, Hendon, N.W. ... ... (This gentleman's shares (100) were transferred on February 15th, 1892, and he has ceased to be a member.)	
Col. John T. North, 5, Gracechurch Street, E.C.	200

Then follows a list of shareholders holding 1 share each. Mr. Hammond is the chairman of the company. Registered office, 15, St. Helen's Place, E.C.

Awards.—The Glasgow and West of Scotland Technical College students are well to the front in the printed lists of the successful candidates in honours at the last examinations of the Science and Art Department; in fact, they are said to have secured more honours passes than the students of any other college in the kingdom. The first Queen's Prize in magnetism and electricity, in applied mechanics, and in steam, has been gained by three students who attended classes at the Bath Street Science and Arts Buildings, taught by Prof. Jamieson and his assistants; and further, that of the eight Queen's Prizes coming to the Technical College, six fall to their share, besides five first class and four second passes in the honours stages of these subjects.

CONTRACTS OPEN AND CLOSED.

OPEN.

Swansea—January 4th. The Swansea Harbour Trustees invite tenders for the working, maintenance, and renewal of their electric light machinery and plant for five years (subject to earlier determination by the trustees). Particulars, information, and forms of tender may be obtained on application to the trustees' engineer, Mr. A. J. Schenk. Tenders to be addressed to Mr. Talfourd Strick, clerk, Harbour Offices, Swansea.

Wolverhampton—January 2nd. For the supply of an overhead travelling crane for the electric light station, for the Wolverhampton Corporation. Specifications, with forms of tender, can be obtained at the office of Mr. F. Harman Lewis, borough electrical engineer, Town Hall, Wolverhampton. Tenders to be addressed to the Chairman of the Lighting Committee.

CLOSED.

Fleetwood.—The tender of the Brush Electrical Engineering Company, London, for lighting the town with the electric light, has been accepted by the Improvement Commissioners. The scheme is estimated to cost £11,000.

The other tenders received were:—Messrs. Parsons & Co., Messrs. Siemens Bros. & Co., Messrs. Greenwood & Batley, Limited.

Sunderland.—For some time past the Highways Committees of the Sunderland Corporation has had under consideration the tenders for the supplying of the necessary plant for the introduction of the electric light into the streets of that town. The following have just been accepted:—Boilers and mountings, Messrs. Hawkesley, Wyld & Co., Sheffield, £1,380; engine and dynamos, Messrs. J. H. Holmes & Co., Newcastle, £4,340; motor alternators, Crompton and Co., Chelmsford, £1,352; batteries, Electrical Power Storage Company, £763; insulated cables, India-Rubber Works, Silvertown, £2,592; road work, Messrs. Simpson, Newcastle, £2,590; ironwork, Messrs. McLaren, Glasgow, £296; stonework, Messrs. Wilks and Maplebeck, Birmingham, £236. The total amount of the tenders is £15,074, against a sum of £21,000 estimated. At the next meeting of the Town Council the members will be asked to confirm the acceptance of tenders, and to grant the committee permission for securing the loan of a sum not exceeding £25,000 for the carrying out of the whole scheme.

BUSINESS NOTICES, &c.

The Universal Electrical Directory (J. A. Berly's).—The above directory is now in the press, and all insertions, corrections, and advertisements for the 1894 issue, should be forwarded at once to H. Alabaster, Gatehouse & Co., 22, Paternoster Row, London.

Water Power in India.—Some time ago Mr. Thomas Oddy, of River Street, Rochdale, received instructions to prepare specifications, estimates, reports, &c., for the utilisation of a waste water power scheme for electromotive and lighting purposes in Southern India. It is intended to transmit 12,000 H.P. (or its equivalent in lighting energy) from some extensive waterfalls to two large towns some distance away. The towns named are so far apart and away from the falls, that it will necessitate a cross country power transmission line (poles and conductors) being laid, 110 miles in length. Some idea of the magnitude of the scheme will be gained from the following details extracted from the reports:—"3,000,000 cubic feet of water per minute are precipitated over the falls, with a clear drop of 200 feet; 12 1,000-H.P. turbines will be required, 12 towers, 10 bridges, 144 electric alternators, motors, and dynamos, of an average capacity of 250 H.P. each; telephonic communication from end to end and at five intermediate stations; 3,300 poles, 30 feet long each; 24,000 miles of wire made into cables; 2 large central station buildings; 2 transformer stations; 96 transformers of 250 H.P. each; massive switchboards, weirs, flumes, sluices, 32

cottages for workmen, stables, 9 horses, land, &c., &c. The whole scheme when completed will cost £350,000. After making allowance for interest on this loan, paying £10,000 as a yearly instalment to decrease loan, paying working expenses, inclusive of cost of maintenance, and depreciation of plant, machinery, and buildings, a profit of £7,000 per annum will be gained. This profit will increase £400 every year as the £10,000 subsidy is paid back on account of loan." The current will be utilised for electro-driving power and lighting for cotton mills, corn and rice mills, domestic purposes, cooking, machine shops, pumping, cranes, hoists, mineral mining and coal cutting, haulage of canal tug-boats, tramways, railways, and various other purposes. He is now also engaged on a similar scheme for some public authorities in Southern Russia. This project is for transmission of 5,000 H.P. 93 miles, from waterfalls which have been running to waste up to the present.

Constantinople in London.—We referred on a former occasion to the elaborate fittings being made for the electric lighting of Constantinople at Olympia by Messrs. Benham & Froud, and have

FIG. 1.

now the opportunity of illustrating some of the more important. Fig. 1 represents the large polished brass covers for arc lamps. These are perforated and lined with transparent ruby, have brass rings,

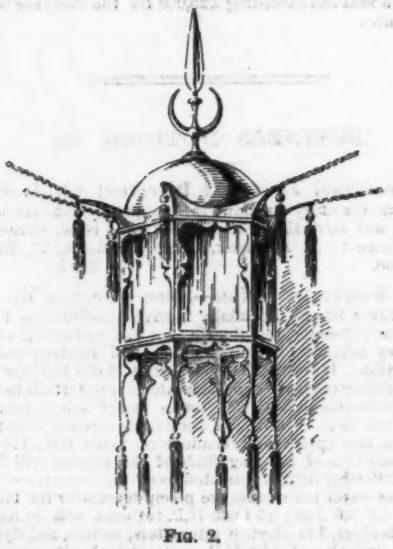

FIG. 2.

drops, and outer brass brackets, with crimson tassels. Fig. 2 is one of the brass lamps which are suspended across the streets by copper-colour chains. These have dark ruby domes, polished spears and crescents, and crimson tassels. Fig. 3 shows the form of bracket used for streets and corridors, and is of hammered iron, with brass and copper lantern, diamond glass cylinder, perforated dome with transparent ruby ornaments, with tassels to match. Some other lanterns

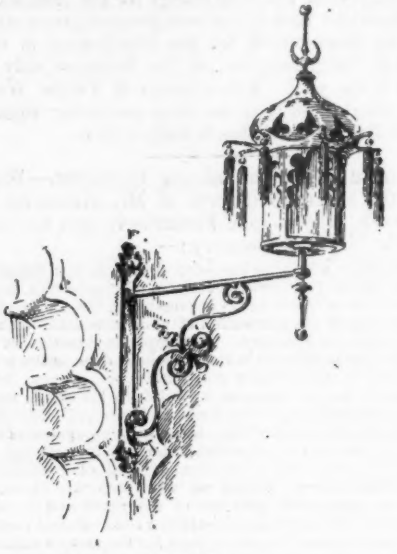

FIG. 3.

of this type, with mica cylinders, are fitted to statuettes in the corridors. Fig. 4 is a bronzed lamp used for streets and bridges. These lamps, and many other fittings for gas, are of wrought iron, with burners in ornamental glass cylinders. The designing and construc-

Fig. 4.

tion of these appropriate fittings owe much of their success to the fact of their having been carried out under the supervision of Mr. R. W. Laws, whose experience in this class of work has been very extensive.

The City Telephone Tubes.—At the Commission of Sewers meeting last week the Clerk read a letter from the City of London Electric Lighting Company on the subject of the telephone tubes in the electric lighting trenches, and also a letter from the Exchange Telegraph Company asking that, in the event of permission being granted for the use of the pipes laid by the City of London Electric Lighting Company, the Exchange Company might be included in the licenses, so as to use the tubes for telegraphs and telephones. The City of London Electric Lighting Company, in their letter, asked that no further delay should take place in regard to the Commissioners giving their consent to the use of the tubes. With regard to the proposed charge of £8 per annum for telephones in the City, the company thought such a charge was not compatible with the outlay of capital, and pointed out that the reduction of charge to 3,000 telephone subscribers would mean that the proposed cheapening of the electric light to private consumers, who now numbered 25,000, could not be carried out. Mr. Gordon, in moving that these matters should be referred to the Streets Committee, remarked that there might be some modification in the terms made by the Commissioners, and that the charge for the telephone service should not exceed £10 per annum.

The Electric Light at Falmouth.—Mr. Grose has just completed an installation of arc lights in the windows of his three shops, the interior of which are illuminated by 50-candle-power incandescent lights. The current is generated by a gas engine.

Ealing Electric Lighting.—At a recent meeting of the Local Board, the Finance Committee reported that, the clerk having announced to them that he had received from the Local Government Board a formal sanction to the borrowing of the board of the sum of £25,000 for electric lighting purposes, repayable over a period of 25 years, the committee recommended that application be made to the Local Government Board for an order authorising the Ealing Board to raise the sum of £50,000 by the creation and issue of Local Board stock. The recommendation of the committee on the subject was not adopted at this meeting, but was deferred for consideration, the formal resolution to be submitted at the next meeting of the board.

A deputation from the Ealing Free Public Library Committee subsequently waited upon the board, and complained that the committee had not been consulted in reference to the proposal that the library buildings should, under the electric lighting scheme, formulated by the board, be lighted by electricity, as a part of the public buildings, under the control of the board. The deputation repeated that the Library Committee were not financially in a position to consent to, or be responsible for, any experiments undertaken in the installation of the electric light in the library premises.

Wolverhampton Electric Lighting.—By the scheme which has been adopted by the Town Council for supplying the town with electricity, it is proposed to provide a generating station in Commercial Road, from which the electrical energy will be transmitted to a central switch station at the Town Hall. From this central station the high-pressure current will pass to various sub-stations in the compulsory area, which will be at the Art Gallery Free Library, and Town Hall, where it will be transformed into low-pressure energy for distribution. The total amount of the tenders, plus £1,320, estimated for arc lamps, is £18,762 14s. 2d. Other items of necessary expenditure will reach £4,020, and the total amount of capital expenditure for which a loan is sought will be as follows:—Plant, £17,442 14s. 2d.; arc lamps, &c., £1,320; other capital items, £4,020; cost of buildings and contingencies, £7,228 5s. 10d.; total, £30,011. The bulk of the work will be entrusted to the Electrical Construction Corporation, Bushbury, and the boilers will be supplied by Mr. John Thompson, of Ettingshall.

Llandudno and Electric Lighting.—At a recent meeting of the Llandudno Improvement Commission Gas Committee, a letter was read from Messrs. R. Belliss & V. Kingsland, submitting a scheme for the introduction of the electric light into Llandudno. They were prepared, with the sanction of the Commissioners, to take immediate steps to form a company of local gentlemen, and apply to the Board of Trade for a provisional order. It was decided to consider the subject at a special meeting to be held in January, the clerk, in the meantime, to report what effect such companies have had on other towns; also to write to Messrs. Belliss & Kingsland enquiring on what terms, if they favoured the proposal, they would be prepared to transfer their undertaking when it had been established.

Robey & Co., Limited.—We are informed that Messrs. Robey & Co., Engineers, of the Globe Works, Lincoln, have converted their business into a limited liability company, with an authorised share capital of £300,000 in preference and ordinary shares, £272,710 of which are taken by the partners and holders of capital in the old firm, no issue of any of the company's share capital having been offered to the public. In addition to the above capital of £300,000, there will be an issue of £125,000 4½ per cent. debentures, making a total capital of £425,000. This change has been made in consequence of the deaths of partners, and to facilitate family arrangements, leaving the present management of the business unaltered.

Electric Light at Stowmarket.—On Thursday and Friday, last week, the electric light was used in the Market Place, Stowmarket, for the first time. The installation was carried out by Mr. Arthur Chapman, of Ipswich, who also lighted Mr. Peddar's Sale Yard on Thursday afternoon. The current was extended from the dynamo in the Sale Yard, in front of the White Hart Hotel, to Mr. Peddar's office, thence to Mr. Bishop's establishment, which was brilliantly lighted inside and out. The dynamo was driven by a portable engine, lent for the occasion, the work being carried out by Mr. H. C. Gooding, of Stowmarket.

Yarmouth Electric Lighting.—The Electric Lighting Committee submitted a report to the Town Council last week, stating that the Mayor had been appointed chairman for the ensuing year, and that the Board of Trade had approved the proposed method of lighting; and that the Local Government Board had both sanctioned a loan of £15,000 for carrying out the scheme, and also approved of the site for the electric lighting station. Mr. Preece is to prepare the necessary specifications. The borough surveyor's plans for the proposed station have been approved.

Lists, Calendars, &c.—Messrs. Jung & Lindig, of Freiberg, have sent us one of their lists of leads and accessories for electric batteries, lead soldering apparatus, &c.

From the staff of the Commercial Cable Company, at New York, we have received a card conveying the season's greetings. This card is an exceedingly neat production, the subject of the illustration being the *Vigilant* launch enclosed in the hollow of a horse-shoe.

We have received from the Electrical Power Storage Company as usual, one of their handy 1894 calendar blotting pads.

Presentation.—Mr. Ernest G. Tidd, C.E., recently engineer and superintendent of Messrs. Paterson & Cooper's contract and wiring department in London, was on the occasion of his marriage presented with a handsome hall gong by the contract department employés, who have been working under him for the last five years or so. Mr. Tidd recently left London to take over the management of Messrs. Paterson & Cooper's ship lighting and Scotch department.

The Electric Light at Prescot.—A special meeting of the Prescot Local Board was held on Wednesday last week to consider the present unsatisfactory electric lighting of the town. A report by the surveyor showed that the defective light was due to some broken joints; and a letter was read from the managing director of the Insulated Wire Company stating that the defects would be remedied without delay. A sub-committee was appointed to wait upon the company in reference to the matter.

Huddersfield Electric Lighting.—The engineer has reported to the Borough Council that an additional transformer chamber will be required in Westgate. A cellar has been decided upon. Enquiries are being made as to the probable number of users of the electric supply in the event of mains being laid in Marsh and Gledholt, and as to the cost of laying the mains, and the estimated income to be derived therefrom.

Church Lighting.—An electric light installation is being fitted up in St. Paul's Church, Bray. The work has been entrusted to Mr. C. Norman Robinson, of Dublin, the current being obtained from the Bray Electric Light and Power Station.

It has been decided to introduce the electric light into St. Nicholas Church, Bristol. The work has been entrusted to Messrs. King, Mendham & Co.

Cowpen and the Electric Light.—At a recent meeting of the Cowpen Local Board correspondence was read from Messrs. Sanderson & Co., electric lighting contractors, explaining that the absence of electric light was due to the disastrous effects of the late gale. Globes, wires, &c., had been destroyed, but everything possible to facilitate the work of repair had been done.

Electric Lighting for Stirling.—The Provost's committee reported to the Town Council last week that they had resolved, provided the sanction of the Electric Lighting Committee of the Glasgow Corporation was obtained, to ask Mr. Arnot, their electrical engineer, for his opinion and advice in connection with the proposed scheme of electric lighting for Stirling.

Perth Electric Lighting.—Last week the first private installation of electric light in the city was inaugurated. The premises to which the new light has been supplied are the private residence of Mr. M'Arthur, 56, George Street, and his business apartments at 10, Bridge Lane.

Cardiff Electric Lighting.—Tenders have been accepted by the Electric Lighting Committee for 250 lamp columns, lamps, and lamp-holders respectively. It has been decided to erect about 40 additional lamps in various parts of the town.

Mill Lighting.—Some spinning mills in course of erection for the Beehive Spinning Company, Limited, Bolton, are to be completely lighted by electricity. Each of the three mills will contain about 700 to 800 lamps, and the necessary generating plant.

Newport and the Electric Light.—A deputation from the Newport County Council last week paid a visit to Bristol, and inspected the electric light station.

Electric Light at Redruth.—Mr. W. H. Smith, boot and shoe manufacturer, and Mr. W. Williams, butcher, have decided to instal electric light in their shops in Fore Street, Redruth.

CITY NOTES.

Stock Exchange Quotations.—Application has been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation to:—City of London Electric Lighting Company, Limited: Further issue of 20,000 6 per cent. cumulative preference shares, Nos. 20,001 to 40,000.

The Stock Exchange Committee have appointed a special settling day as follows:—Tuesday, January 16th, 1894, City and South London Railway, £67,130 perpetual 4 per cent. debenture stock, and ordered the same securities to be quoted in the Official List.

Bedford Electric Light Company.—The annual meeting of the shareholders was held on Wednesday, 13th inst. Mr. G. Haynes was the retiring director, and Major Moberly was elected auditor. Legal notice had been given to the Corporation and the Board of Trade of the company's intention to apply for a provisional order.

Salt Lake and Ogden Gas and Electric Light Company.—Notice is given by the Gas, Water and General Investment Trust, Limited, that the coupons due on January 1st next on the first mortgage 6 per cent. gold bonds of the Salt Lake and Ogden Gas and Electric Light Company will be paid at the National Provincial Bank of England, Bishopsgate, E.C.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 22nd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,446.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation December 20th.	Closing Quotation, December 27th.	Business done during week ended December 27th, 1893. Highest.	Lowest.
184,500£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	101 —104	101—104	...	...
1,134,640£	Anglo-American Telegraph, Limited	Stock	42 — 44	43 — 45	43⅜	...
2,932,680£	Do. do. 6 p. c. Preferred	Stock	80½ — 81½	81½ — 82½	82	81½
2,932,680£	Do. do. Deferred	Stock	7½ — 7⅝	7⅝ — 8	7⅞	7⅝
130,000	Brazilian Submarine Telegraph, Limited	10	11½ — 12⅛xd	11⅝ — 12⅛	11⅝	11⅝
18,700£	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	...	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	108 —112	109 —113	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅝ — 2¾	2⅝ — 2⅝	2 9/16	...
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ — 2⅜	2⅛ — 2⅜	...	...
125,000£	Do. do. 4½ per cent. Debenture Stock	Stock	105 —107	105 —107	106	...
20,510	Charing Cross & Strand Electricity Supply Nos. 1 to 6, 215 to 718, and 10,001 to 30,000	5	4½ — 5	4½ — 5	...	...
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	2 — 3	2 — 3	...	...
630,000£	City and South London Railway	Stock	28 — 33	28 — 33	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11¼ — 11⅜	11¼ — 11⅜	...	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	12⅞ — 13¼	12⅞ — 13¼	13	...
10,000,000$	Commercial Cable, Capital Stock	$100	140 —150 xd	140 —150	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	10/-	1/16 — 3/16	1/16 — 3/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	4 — 4½	4 — 4½	4 3/16	...
50,000£	Do. do. 5 p. c. 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	96 —101	96 —101	...	...
16,000	Cuba Telegraph, Limited	10	11½ — 12½	11½ — 12½	11⅞	...
6,000	Do. do. 10 p. c. Preference	10	18 — 19	18 — 19	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½ — 3½	2½ — 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	8½ — 9½	8½ — 9½	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜ — 11⅝	11⅜ — 11⅝	11½	...
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	15 — 15¼	15 — 15½	15 1/16	15
70,000	Do. 6 p. c. Preference	10	15⅞ — 16¼	15⅞ — 16¼	15⅞	...
105,900£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 —111	...	...
1,294,100£	Do. 4 p. c. Mortgage Debenture Stock	Stock	114 —117	114 —117	114¾	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15½ — 15⅝	15½ — 15⅝	15¼	...
62,700£	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	103 —106	...	...
222,800£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	...	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	114 —117	114 —117	...	...
108,700£	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	...	...
146,800£	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	...	...
300,000£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	103 —106	103 —106	...	...
200,000£	Do. 4 p. c. Reg. Mt. Debs. (Mauritius Subsidy) 1 to 8,000	25	106 —109 %	106 —109 %	107	106¼
120,000	Electric Construction, Limited, Nos. 1 to 120,000	£2	¼ — 1	¼ — 1	⅜	...
12,845	Do. do. 7 p. c. Cum. Pref., Nos. 1 to 12,845	2	¼ — 1	⅜ — 1¼	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	... ...	... ...	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	⅛ — ⅜	⅛ — ⅜	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	0 — ¼	0 — ¼	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	½ — 1½	½ — 1½	⅜	...
180,227	Globe Telegraph and Trust, Limited	10	8½ — 8⅝	8⅝ — 8⅞	8 13/16	8 11/16
180,042	Do. do. 6 p. c. Preference	10	15½ — 15⅝	15⅝ — 15⅞	15⅝	15⅝
150,000	Great Northern Tel. Company of Copenhagen	10	20 — 20½	20 — 20½	20⅜	...
200,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	104 —107	104 —107	...	...
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ — 5½	4½ — 5½	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6 — 7	6 — 7	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½ — 22½	21½ — 22½	22⅜	22
200,000£	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	40 — 43	40 — 43	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	1 — 2	1 — 2	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4½ — 4⅝	4½ — 4⅝	4 7/16	4 7/16
15,000	Do. do. fully paid	5	6½ — 6⅝	6½ — 6⅝	6⅝	5⅝
37,500	Liverpool Overhead Railway Ordinary, fully paid	10	5 — 5½	5 — 5½	8¼	4⅜
6,295	Do. do. Pref., £6 paid	10	6½ — 6¾	6⅜ — 6¾	6⅜	...
37,548	London Platino-Brasilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000£	Do. do. do. 6 p. c. Debentures	100	105 —108	105 —108	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£10 paid)	10	7⅞ — 8¼	7⅞ — 8¼	8¼	8
50,000£	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	103 —106	103 —106	...	...
15,000	Monte Video Telephone Co., Ord., Nos. 1 to 15,000 fully paid ...	5	½ — 1½	½ — 1½	...	...
28,000	Do. do. 6 p. c. Pref., Nos. 1 to 28,000 fully paid	5	2 — 3	2 — 3	...	...
484,597	National Telephone, Limited, Nos. 1. to 438,984	5	4⅝ — 4¾xd	4⅝ — 4⅞	4 13/16	4 11/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	13½ — 14½xd	13½ — 14½	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13 — 14 xd	13 — 14	...	...
119,234	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5⅛ — 5⅜xd	5⅛ — 5⅜	5⅛	...
726,477£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	113 —115	113 —115	114½	113½
48,800	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,452	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	4½ — 5½	4½ — 5½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	⅛ — ...	⅛ — ...	...	...
100,000£	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	100	102 —105	102 —105	...	...
11,802	Reuter's Limited	8	5½ — 6½	5½ — 6½	...	...
19,980	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	5½ — 6	5½ — 6	...	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7⅞ — 8¼	7⅞ — 8¼	...	...
3,381	Submarine Cables Trust	Cert.	114 —119	114 —119	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	2¼ — 2⅜	2¼ — 2⅜	2⅜	2 5/16
37,350	Telegraph Construction and Maintenance, Limited	12	36 — 38	36 — 38	...	...
150,000£	Do do. do. 5 p. c. Bonds, red. 1894	100	105 —108	105 —108	...	...
58,000	United River Plate Telephone, Limited	5	2 — 2½	2 — 2½	...	...
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	90 —100	90 — 100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5½ — 6½	5½ — 6½	...	...
260,900£	Do. do. do. 5 p. c. Debentures	100	98 —101	99 —102	99½	...
30,000	West Coast of America Telegraph, Limited	10	2 — 3	2 — 3	2 7/16	...
150,000£	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	99 —103	101 —104	...	...
64,242	Western and Brazilian Telegraph, Limited	15	6 — 6½	6 — 6½	...	...
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5½ — 5⅝	5½ — 5⅝	...	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1½ — 1⅝	1½ — 1⅝	...	...
178,200£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	104 —107	...	...
222,700£	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	104 —107	...	...
88,321	West India and Panama Telegraph, Limited	10	1 — 1½	1 — 1½	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9⅝ — 10¼	9⅝ — 10¼	...	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8¼ — 9½	8½ — 9½	...	...
80,000£	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	* 100	108 —111	108 —111	...	...
$1,214,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	113 —118	113 —118	...	...
169,000£	Do. do. 6 p. c. Sterling Bonds	100	102 —105	102 —105	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5 — 5½	5 — 5½	5⅝	5

† Unless otherwise stated all shares are fully paid.

† Quotations on Liverpool Stock Exchange.

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid) 5¼—6¼.—Brush Company, 4½ per cent. Debenture Stock, issued at 1 per cent. premium, 106—108.—Electric Construction Corporation 6 per cent. Debentures 87—92.—Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.—Founders' shares, 200—225.—Electricity Supply Corporation, Ordinary of £5, 5—5¾.—House to House Company (£5 paid) 1—1¾.—Do. 7 per cent. Preference of £5, 5¼—5¾.—Do. 6 per cent. Debentures of £100, 101—103.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 4¾—5¼, 1st Preference Cumulative 6 per cents., £5 (fully paid), 1¾—6¼.—Liverpool Electric Supply, £5 (fully paid) 6¼—6¾.—Do. £3 10s. paid, 4¼—4¾.—London Electric Supply Corporation, £5 Ordinary, ¾—1¼—Manchester Edison and Swan Company £5 (£1 paid), 4—4¼.—Queen Anne's Mansions Lighting and Heating 6 per cent £100 Debentures, 101—103.—Yorkshire House-to

Bank rate of discount, 3 per cent. (October 5th, 1893.)

ELECTROLYTIC ACTION OF STREET RAILWAY CURRENTS.*

BY R. FLEMING.

DURING the last few years of development of the electric railway a serious difficulty has arisen in connection with it—namely, the electrolysis of water, gas and other pipes, electric lead covered cables, and all metallic conductors that may happen to lie parallel with the track. Even the supplementary and bond wires of the track have been attacked, as might be supposed, owing to their position.

Various suggestions for remedies have been given from time to time, but none of these that I have seen will be of very much benefit.

Reversing the polarity of the rails has been the chief remedy sought where this evil exists. This is not a remedy by any means; it merely transfers the action from one point to another, as electrolytic action surely will take place as long as the current leaves the track at one point and returns at another. This it will do as long as the return circuit (the rails) has a high resistance.

It is the difference of potential due to this high resistance between the point where the usual ground wire is joined to the track and the far end of the line, where there are cars running, that causes the current to be deflected into the ground and to follow the pipes as long as they offer a better path than the rails.

Another suggestion was to make an electrical connection between the tracks and pipes at as many points as possible.

This is not to be depended upon, as there are bound to be high resistance joints in all pipe lines. In such a case the trouble would be only intensified, as the action would be concentrated at either side of the joint, and disintegration would take place in a very short space of time.

The only effectual remedy that I can see, is to as nearly as possible isolate the track from the ground, and make the rails in reality a complete return circuit of low resistance, not a high resistance, or perhaps interrupted circuit, as they usually are owing to broken bonds and rusted fish-plates and bolts.

No amount of bonding will insure a continuous circuit for any length of time, on account of the liability of the bonds getting broken through the electrolytic action of the current when they are covered by moist earth and gravel, through mechanical vibration due to passing cars, and by waggon wheels, &c.

Even a supplementary wire placed in the usual manner will not remedy the difficulty, owing to the vigorous manner in which this wire is itself attacked by electrolysis, which will in a short time give it a very attenuated appearance and eventually eat it away completely.

By watching the operation of a great many electric street railway lines it is easy to see that a large percentage of the energy generated at the power station is not expended in driving the car motors. A large portion is used up in overcoming the resistance of badly proportioned feeder and trolley lines, and a still larger portion is expended in forcing current through high resistance rail joints. When these fail altogether the current passes through the ground and the pipes and cables that are buried there.

This is also the case with supplementary wires that are too light for the work they have to do, or are perhaps broken in one or more places. It is this stray current that causes all the mischief as it enters and leaves the different systems of piping.

This annoying trouble can be in a great measure, if not altogether, avoided by taking the supplementary wire from the rails, where it is subject to various agents of destruction, and placing it in the conduits when such are used, or on the poles where it will be out of harm's way.

It should be run in the same manner that the other feeders are and should be calculated with the same nicety, for the work it has to do and the carrying capacity of both should be about the same.

This return feeder should be carefully joined to the rails at intervals of from one hundred to four or five hundred feet, depending on the traffic. For heavy traffic lines there should be a tap at every pole, and in addition the rails should be well bonded, double bonded and interconnected, if possible.

The wires leading from the rails to the poles should be thoroughly insulated from the ground, so as to prevent their being eaten away by electrolysis, as they are bound to be if left unprotected.

This, of course, will add to the first cost of construction, but it is not necessary that the wire be expensively insulated. A bare wire will answer the purpose as well as any. There is no question about the economy of such a plan, as the reduced $C^2 R$ loss will pay for the additional outlay in a short time.

* *Western Electrician.*

THE CONTROL OF HEMORRHAGE BY ELECTRICITY.

THE control of hemorrhage is often a difficult matter, especially in connection with internal operations, such as have frequently to be carried out in gynæcology. The positive electrode of a fairly strong continuous current has sometimes been found very effective in stopping the hemorrhage, but on the other hand it has sometimes proved unavailing. Dr. Augustin Goelet, of New York, has lately done good service by calling attention to the probable causes of failure, and by pointing out how they may, to a great extent, be avoided. In speaking of the *rationale* of the process, by which bleeding may be stopped electrically, he says: "The action which brings about this result (the control of hemorrhage) is due to several things operating together; first, an electrical osmosis which takes place in the direction of the current from the positive to the negative pole, whereby depletion with paling and drying of the tissues in the vicinity of the positive pole is produced; second, the congestion or blood stasis of the uterine body or attached fibroid mass is relieved; third, the detachment of adhesions between contiguous peritoneal surfaces, which is one of the first results observed from the use of the current, allows the mass to rise in the pelvis, and removes one of the causes of obstructed circulation; fourth, cauterisation and destruction of the diseased endometrium, resulting from the liberation of oxygen, chlorine, acids, &c., at the point of contact of the positive pole with the tissues, produces eventually a dense, unyielding eschar, which acts as a barrier against subsequent bleeding." He then goes on to show that one of the frequent causes of failure is insufficient and imperfect contact between the electrode and the endometrium. The need for attention to this matter of actual and complete contact between a metal or carbon electrode and the surface to be dealt with, is so obvious, that one is at first surprised to find that many serious failures have been allowed to result from its neglect. It must be remembered, however, that the class of operations referred to by Dr. Goelet are carried on inside the body, where sight, and even direct touch, often cannot be employed to guide the movements of the operator, or inform him of the exact position of the electrode with reference to the surface he desires to act upon. Failure is also declared to arise through making the application when the bleeding is very active, the result of which is that "The action is expended upon the blood filling the cavity, which is constantly refilled as it becomes emptied, and the result of the decomposition is constantly being washed away." On this point Dr. Goelet goes on to say: "However, if the applications are persevered with, and are properly made, they will, in the majority of cases, control an active hemorrhage; but success should not be expected from one or two or several applications at this time." It is with satisfaction that we learn, from such an authority, that there is a method of controlling active hemorrhage, which he considers, from actual experience, to be a very effective one. This method is one on which we made favourable comments some months ago. It is called "cupric electrolysis," and is part of a system of metallic electrolysis recently introduced by Gautier, of Paris. "It may be employed in the midst of an active bleeding with certainty, since the decomposition of the copper electrode by the action of the positive pole liberates an astringent salt, the oxy-chloride of copper, which produces coagulation. An additional reason for an immediate result lies in the fact that

it is driven into the tissues by electrical osmosis, and the structures for some distance beneath the surface are stained by it." Gautier's experimental determination that no harm resulted from the absorption of this salt, has been borne out by observations made "upon the patients" treated by this method.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

THE annual general meeting of the Institution was held on Thursday, December 14th, Mr. W. H. Preece, F.R.S., President, in the chair.

The formal business having been disposed of,

The PRESIDENT referred in feeling terms to the death of Prof. Tyndall, who in the early days of the Institution was a frequent attendant at its meetings.

The SECRETARY, having read the annual report of the council, the President invited observations from members.

Mr. ANSELL said he rose to ventilate the question of the due representation of all classes of the profession on the council. Having read a memorial on the subject, Mr. Ansell said that as yet time had not admitted of their obtaining many signatures, but there was no doubt that, when the matter was put before them clearly, a great many would adhere to the propositions therein laid down. There was a feeling that telegraph interests were not fairly represented, and if something was not done, it was probable that there would be a very large secession of members from the Society. At midsummer, 1846, there were 84 of them associated with the old Electric Telegraph Company, the earliest pioneers of the telegraph systems of the world; there were only 11 of them now living. But it was from that small body of men that had sprung the magnificent Institution which they now saw. The men who were associated in the building up of that Society were giants to what they who preceded them were; they had gone ahead of them. But by virtue of having laid the foundations of what was now a magnificent Institution they claimed to be represented on the council.

The PRESIDENT said he thought Mr. Ansell would find that the body of the Institution was with him on this question, and the council also; and if he would propose that the writers of the memorial should form a committee to consult with the new council, the old council would certainly advise the members of the new council to meet the committee and discuss the whole question.

Mr. ANSELL said if the council would accept the memorial as a basis, the memorialists would be delighted to meet the council, and he hoped they would be able to make some sort of arrangement that would satisfy the requirements of those he represented.

Mr. GROVE suggested that some effort should be made to place copies of the papers to be read in the hands of the members at an earlier period than they were now obtainable. With their large membership a general distribution might be troublesome and expensive, but he would suggest that if necessary a charge should be made to cover the cost of such a circulation.

The PRESIDENT said there were difficulties in the way of carrying out the suggestion, but the chief of them was the author. If authors would only let them have their papers a week or two beforehand, they might be able to do what was suggested. There was some difficulty in getting papers, so that they rarely had any in hand. If members would give them plenty of papers they would have them printed and circulated in time.

The report of the council was then put to the meeting and carried.

The usual votes of thanks having been passed, the PRESIDENT announced that the officers and members of council as printed on the balloting list had been elected.

The discussion was then resumed upon Prof. George Forbes's paper on the UTILISATION OF WATER POWER AT NIAGARA.

Mr. FERRANTI said there were several important features in which the dynamo proposed was novel. One of them was the method of insulating the coils. He had not heard of any other proposition except that of Prof. Forbes, for doing it in that way. It might be interesting to know that in the provisional specification of a patent he abandoned, occurred the following passage: "Another method is to enclose the armature in insulating material, leaving a sufficient clearance all over the surface of its conductors to enable the oil to run in and entirely cover, or as nearly as possible, all the conductors. This oil may be kept under pressure as above explained" There was a provision for tubes or vessels from the outside of the oil case for facilitating the circulation, and for conveying away heat. He let that drop, and he thought wisely so. It might be worth the consideration of Prof. Forbes and the engineers of the company whether they would adopt this method as at present designed. He recognised in the design of the dynamo most distinctly, the design of Mr. C. E. L. Brown, of Baden, perhaps the man who had done most towards high pressure work and long distance transmission. The subjection of the magnets to centrifugal force and the insulation with mica were essential features of the design sent in by Mr. Brown to the company. With regard to the cooling of the bearings, there was a very ingenious device, of which doubtless many had thought of making an electrical contact when the bearing overheated. He thought it said in Prof. Forbes's paper that when this contact was made, water could be turned on to cool the bearings. It was a very general practice amongst English and Continental engineers to circulate water continually in the jacket round the bearing, which of course was preferable to throwing water on from a hose according to marine practice, but in this case he should say it would be very effective if water were always left on. There should surely be enough water at Niagara to make this possible. He considered the exciting a large plant like that in series was anything but the best arrangement; he believed that the old parallel method of exciting had many points in its favour. With regard to the dynamos being built by the Westinghouse Company for the Cataract Construction Company, he was surprised to see that, after all that has been done with high tension work, the failures made and the successes achieved, they have not thought fit to go any higher than 20,000 volts. The question of transforming up was, in practice, a very awkward one. It led to many objectionable results, and was especially bad where it was combined with other dynamos working direct on the circuit at high pressure. He believed it was contemplated to make those dynamos of higher pressure than 20,000 volts; then, he supposed, the old ones would have to be re-wound, remodelled, or worked on this objectionable plan. There was, he thought, a very great difference which might not appear at first sight between designing dynamos and building them as a regular practice; in fact, a thing which one made an ordinary daily business, and getting together a collection of all the information which was available in the world, and this in no limited sense, and then, without any previous knowledge of dynamo design, and especially building, and more especially running, to design a machine which is supposed to fulfil great expectations. This was perhaps the point of greatest difficulty in the company's scheme. If the designs of any one of the many constructors had been taken; if it had been left to those who made the best designs to design finally and build the dynamos, instead of contemplating the idea of designing a machine for them, it would, he thought, be a more satisfactory way, and more certain of success. With regard to that of the construction of the line and the E.M.F. to be used, as he understood it, it was proposed to use an E.M.F. of 20,000 volts, on the assumption that as at Deptford there had been used an E.M.F. of 10,000 volts between one of the conductors and the earth, or rather, between the inner portion of the concentric cable and the earth, the risk of failure would be no greater with 20,000 volts than with 10,000. He thought this was a great fallacy. If they had two cables, both insulated from earth, and charged in this way, it was exceedingly unsuitable, and a very undesirable plan. If they adopted the safest method of conveying electricity, namely, by concentric cables, then the outer conductor only took the same potential as that of the earth. If the two cables were separate, they were liable by any accident which might occur in practice to have one put to earth. Then they would have a reversal of strains, the whole theory of 20,000 volts being as easy to upset as 10,000, and they would have conditions which they had not provided for. He thought therefore it was rather a delusion to imagine that equal safety with 20,000 volts, and both conductors insulated, was to be obtained in comparison with the safety of 10,000 volts and one conductor to earth at one place. With regard to the subway for the conductors, he thought it was quite possible if any fault did occur in the subway, that it would cause a very serious state of affairs, and would possibly lead to the complete breakdown of the system. He thought the subway the most unsatisfactory way of dealing with the question; but that was, of course, only his personal opinion. Next, they had the question of periodicity. He ventured to say that so high a periodicity as 100, or even 86, as at Deptford, would be fatal to an economical working of the system. They came, now, to a most interesting question, How was electricity to be transmitted to a very great distance, and by what method was it to be done? Was it to be done by alternating currents, or by continuous? He must say he did not see the faintest chance of its being done with continuous, but, at the same time, he saw very grave difficulties in the way of doing it by alternating currents. He hoped some day the company would take current as far as New York City, a distance he believed, of 500 miles, and to Chicago, a distance of 500 miles in the other direction, and he did not see why it should not be commercial if it were done sufficiently well. The question was, upon what system should it be done? It was a matter which would require the very gravest consideration by the experts of the company before any satisfactory conclusion could be arrived at. There was a point which he thought ought to be drawn attention to, and that was that the company contemplated building the machines in America, and that not one of the designs sent in by competitors but was already covered by American patents, and they would have to reckon with the American patentees, and not with the people who gave their years of work and sent in their designs. It was upon this basis that those designs had been got out; it was upon the work of the world—the electrical world—unrecompensed, that the undertaking would be carried out at Niagara. He did not think, himself, that it would answer so satisfactorily as though it had been put into the hands of one constructor, like Mr. Brown, who had already known what it was to build such work upon a lesser scale, but of the same nature. He did not attach the slightest blame to Prof. Forbes, and he was sure no one would think he did so; but it had been a beautifully worked arrangement which everybody had fallen into, and they could only regret the result.

Mr. ALEXANDER SIEMENS said it was only right to the Commission who asked for the tenders that he should put the matter from a different point of view from that represented by Mr. Ferranti. Mr. Ferranti had said that he did not compete; therefore, perhaps, he was not acquainted with the conditions upon which the tenders were given. He (Mr. Siemens) had the pleasure at the time of speaking to the President of the Commission, who explained to him that the conditions were to be that the different competitors were to send in detailed designs, and, if successful, superintend the construction of the machinery in America for a commission of 2½ per cent. or 5 per cent., he forgot which. He told the President of the Commission that

under the circumstances they could not compete, except by giving a general design. Under those conditions they competed, but did not send detailed designs, and, as a matter of course, were excluded from the prizes. But he was perfectly certain that nobody who read the conditions under which they tendered could say that it was not from the beginning the intention to construct the whole of the machinery in America. They all knew of the high import duty in America, and of the cost of freight for such heavy machinery, and that it was only natural that it should be done in America. This was perfectly plainly stated in the conditions of tendering, and also that the prizes were to be £500 to £200, which he quite agreed was not an adequate compensation. He did not think any question ought to arise about being able to send a current of 20,000 volts through underground cables. He would remind them that there was a concentric cable which had an alternating current of 24,000 volts between the Frankfort on Main Exhibition and the Marine Exhibition, running all the time, and without any difficulty whatever. His firm had since been using the same cable in experiments with 50,000 volts, and had occasionally gone up to 60,000 volts, and there had never been any difficulty or anything wrong with the cable. Therefore he, for one, would be perfectly ready to supply cables that would carry 20,000 volts. Another point which had been insisted upon was that it was quite out of the question that a continuous current could do such a transmission. Well, he was not so sure about that. Their own project for the Niagara transmission was for continuous current, using machines in series, and also motors in series, and from the experience they had gained he was not at all afraid about being able to insulate everything sufficiently well to be able to use that pressure. He was not sure that the Cataract Construction Company would not be converted to the continuous current before it had completed its installation.

Mr. S. H. EVERSHED said that there was one great argument for using as low a frequency as possible, the enormous inductive drop in the lines if run at the 100 periods of Mr. Mordey. He fully agreed with Mr. Mordey that 100 were the best if that difficulty could be got over, but it was a very serious one. If they had mains of 3 square inches in section, as Prof. Forbes would have, at 2,000 volts, and placed those mains 6 inches apart in every mile, if they ran at 100 periods, they would have a drop of 880 volts due to induction; the resistance drop was negligible. Running at 25 periods the drop in the primary was reduced to 192 volts due to induction, while the resistance drop was 27 volts. On that ground alone Prof. Forbes appeared to him to have an unanswerable argument in favour of low frequency in this particular case.

Mr. CROMPTON said the question which was of real interest to them was what would be the cost to the users in Buffalo, or in the more distant towns? How would it compete with the cost of power produced in those towns. There was nothing in the paper to give them an inkling as to the form of calculations taken out under this head. He had been forestalled in many of the remarks he would have made by Mr. Ferranti. The barefaced attempt to pick the brains of the world, and then to utilise the information gained for the benefit of the American manufacturers, was not a thing to be admired. He was sorry to say the attempt was often made in this country; he spoke feelingly. There were many who had spent their blood and treasure for many years in the perfecting of the mechanical details and the other details of electrical machinery, and who could not get any reward for their labours, simply because no system of patent laws could cover every little detail of design. The regular modern habit was for the last comer to pick the brains of the world, so they must not blame the Americans in this case. They were only doing on a large scale what they were all doing on a small one. Mr. Siemens talked of there being no difficulty in making cables to withstand 20,000 volts, but he thought he was forgetting what the cost of those cables would be. Prof. Forbes had tried to get out of the difficulty by using bare copper, and of course he (Mr. Crompton) was with him there. But he would not like to be in that culvert when 20,000 volts were going on. He did not think continuous currents had been condemned on sufficient evidence. He did not agree with Mr. Ferranti that 40 periods were good enough to produce good electric lighting. He had seen many of Ganz's stations at 42, and the arc lighting was disgraceful—so disgraceful that whenever it was in competition with another system in the same town, they lost their arc work.

Mr. WEEKS, Mr. MAVOR and Major-General WEBBER having taken part in the discussion,

Mr. KAPP gave an abstract of a communication from Mr. C. E. L. Brown. Mr. Brown advocated a higher frequency than Prof. Forbes, and with regard to running in parallel, said he had been unable to detect any difference between low frequencies such as 15, and up to 100. With regard to transformers, he said no doubt high frequency was best, and he went on to point out that it was far more difficult to design large transformers to run cool than small ones. Motors might be suitably designed for high frequencies to give results quite as satisfactory as with low, until they got above a frequency of 60. Considering the impossibility of supplying light at the same time as power, it was advisable to be above 30, and for arc lighting the frequency should be not less than 40. To adopt the two-phase system, using four wires seemed to him a bad arrangement, and judging from his own experience, none but bad results could be obtained. It certainly seemed remarkable, considering the number of designs sent in, many of which were extremely good, that Prof. Forbes should have decided upon about the worst arrangement possible for his machine. He could not imagine a more inconvenient arrangement than the magnetic wheel revolving outside the armature, so that it was impossible to get at the machine while in motion, whilst losing entirely the ventilating effect of the revolving wheel for the cooling down of the armature.

Prof. FORBES said he had to congratulate them on the fact that that evening's discussion had somewhat redeemed the character of the Institution. There had been shown more of that capability of dealing with a problem of such importance which they would expect from such an institution than was shown on the previous evening. Those who had really studied this problem to some extent, who know what the difficulties were, and where the pitfalls were, must have felt that some of the gentlemen who took part in the discussion on the first night had not even begun to grasp the character of the problem before them. He, himself, had felt nothing but sorrow for the position of that Institution in having such speeches made on a matter of so much importance. That evening there had been more appreciation shown of the difficulties of the work and of its character generally, and the discussion had been carried on with less show of ignorance. There had been some hard words and strong opinions expressed, sometimes injudiciously, sometimes apparently after considerable thought, but nearly every adverse view had been combated by those who had spoken from other parts of the room. In the discordant views expressed by the various speakers, he saw a reflection of the train of reasoning which had been going on in his mind during the years he had devoted to the subject, and he saw the beginning of the workings of the minds of those who would have arrived at different conclusions if they had had longer to think about the matter. He was astonished at the manner in which the question of low frequency had been received. He did not claim for himself one atom of credit for having, after most careful consideration, arrived at the conclusion that the lower the frequency they got in the design of their dynamo the better would it be for the working; but now, after the remarks that had been made, he began to look upon himself almost as if he were the discoverer of low frequency. There was very great divergence of opinion with regard to frequency, but he felt confident that as time went on those who had spoken at the previous meeting—Messrs. Kapp, Mordey and Swinburne—would arrive at a different conclusion. If he had the slightest feeling in this matter, which he had not, and wished to gain great credit to himself instead of success in his work, he should enjoy the objections that were being raised by men so distinguished in their profession. He should then look forward with pleasure to the time when he could show the system working well at Niagara, and say, "This is the system which was found to be faulty by Messrs. Mordey, Kapp, and Swinburne." He should then be enjoying the sort of triumph which had been thrust upon him with regard to the question of alternating currents. In the year 1890 he presented to the International Commission a report of the manner in which this work should be done, and insisted that it should be done by alternating currents. Every one of the members of the Commission was opposed to it. Since that time everyone, except one, had come round to the view that alternating currents were the only ones that should be adopted for their purpose, and naturally he felt proud of having insisted upon that at so early a period. Before going on to discuss the different speeches, he wished to say a few words on a subject which Mr. Ferranti had brought forward, and which had also been alluded to in the technical press. It had been said that the International Commission was a farce, and that those who prepared schemes had been treated unfairly. Mr. Siemens had, in a great measure, answered this, and he would not delay them by referring to that part of the subject. But it had been said that it was determined to give to the men who furnished the plans which should be adopted the superintendence of the work. He held in his hands a report which he submitted at the time in which he said that alternating current was to be used, that it was to be of two phases; that 2,000 volts was to be used for the local work, that step-up transformers were to be used to carry it to Buffalo, that the motors were to be synchronising motors, Tesla motors with two phases, and motors with laminated fields and commutators. The International Commission had been absolutely loyal to their compact in giving him the superintendence of this work. The only serious mistake which he made in that report—and he went most fully into details of construction—was to recommend the adoption of Mordey alternators. They knew now that they were not of the right frequency, and that in certain other points they would not suit their purpose. Dr. Fleming's remarks were the redeeming feature on the last occasion; he showed himself to be a practical engineer in the highest sense of the word, that was, a man of great experience in the line which he was discussing, and who knew how to apply theoretical considerations to the solution of practical problems. If the discussion had been barren in certain parts, they had at least heard from him of the methods used at Deptford to overcome electrical resonance, and that was an important point. The endorsement which Dr. Fleming had given to his views he considered to be of great value, and showed that he had given some attention to the subject. When he said that the lines should never be suddenly connected to or disconnected from the machine, he said something which other speakers probably considered might be regarded as an axiom. But although it might be the practice in this country, it was absolutely the contrary to the practice in America. Mr. Mordey entirely failed to grasp the situation. Accustomed as he was to deal only with electric lighting plants, and those what they might, without discourtesy, call comparatively small plants, he did not realise what their scheme was to be, and especially he did not realise that theirs was to be a power distributing plant, and that the electric lighting that was to be done was utterly insignificant compared with the rest of the work. His opinion that he (Prof. Forbes) had thrown down the gauntlet to electric lighting men, showed that he did not realise the nature of the problem; his reference to transformers of small horse-power as being applicable to their case also showed it; his willingness to condemn the artificial load on the ground of expense also showed it. With regard to parallel working, Mr. Mordey argued if 100 periods succeeded, why go down to 25? He (Prof. Forbes) had shown 20 reasons for going down below that. It was true 100 periods would allow of the machines working in parallel without getting out of step. But they wanted more than that; they wanted them to run in step without waste current, passing from one to the

other, and without breakdown. He did not consider that 100 periods would succeed so well as Mr. Mordey would lead them to believe. Mr. Mordey knew quite well that while his alternator worked in parallel, it did not work perfectly; he knew his machine had broken down at times. They at Niagara could not afford to experience such breakdowns as he had met with in his comparatively small machines. Even supposing Mr. Mordey replied that it was not the high frequency that caused the breakdowns, he (Prof. Forbes), as the engineer of important work, could not take the risk, whatever the causes might be. Mr. Mordey's alternator did not work well enough for their purpose. He said in 1891 that before deciding whether to adopt it or not, tests must be made with high resistance between the dynamos in parallel. Mr. Mordey put in a group of Sunbeam lamps in series. The lamps went up and down with a periodicity of a few seconds, and the tendency was to rise to maximum brilliancy, showing that there was a tendency to work rather in series than in parallel. From the moment of those experiments he (Prof. Forbes) felt that the machines were not suitable for their purpose, although he never mentioned it until he was compelled to do so by Mr. Mordey's claims for his special mode of working. Mr. Mordey thought artificial loads would introduce greater dangers. He had been utterly unable to see what those dangers were. Otherwise the objections raised to them was that they were somewhat of a complication. When they put an unloaded dynamo on to full load, there was a considerable drop, and all he claimed for the artificial load was that it was a help to keep the machine from breakdown. They could not afford to have breakdowns. He looked to every possible safeguard that could be devised, even though the expense were something greater. In this case there was no additional expense, because the artificial load, when not being used for that purpose, was useful for other purposes. Mr. Mordey's remarks about skin resistance would be accurate if they could subdivide the 36 square inches required for the conductors of the first 15,000 horse-power used at 2,000 volts. But they could not get space for the enormous conductors unless they massed them together, and at high frequencies the skin resistance would come in. Mr. Mordey's remarks on transformers caused him the most regret, for they showed how far he was from grasping the problem. He did not appear to realise the work that must be done by consulting engineers. An engineer was very little likely to advise such a scheme until he had every detail worked out to a very large extent. Foreseeing difficulties with manufacturers, he set to work to design transformers of low frequencies for every kind of work for which they wanted them. Designing transformers for special cases and for larger sizes than usual was somewhat laborious work, but the results were quite certain when they knew the quantity of iron used. Efficiency of transformers was so high as to be of almost no account at all, when dealing with the large sizes which they required for their work. In those cases there was no difficulty in getting efficiencies much higher than those mentioned by Mr. Mordey, and if even ½ per cent. could be gained by increasing the efficiency, he would prefer to retain the advantages of low frequency. With regard to the question of the E.M.F. of the dynamos, he really hardly understood Mr. Mordey. He wanted them to use 500 volts. If he would estimate the section of copper for 50,000 H.P. or so, he would see the difficulties to be met with. That copper section would be about 400 square inches. He had no doubt Mr. Mordey had never realised that until that moment. He could quite understand that with his type of machine he would not go above 2,000 volts. But he was surprised that he was not able to realise these two facts: first, that with 5,000 H.P. the space taken up was quite immaterial, and in the second place, that if you shirked the difficulty of insulating to 20,000 in the fixed armature of the dynamo, you would have to face it when they came to the fixed transformer. Mr. Ferranti had been good enough to tell them that he had stolen this machine from Mr. C. E. L. Brown; he had also told them that he had been travelling over Europe looking at what manufacturers were doing, asking them for designs, with the full knowledge all the time that their machines were going to be made in America.

Mr. FERRANTI: The company, not you. I said the company sent their engineers, knowing full well that the machines would be made in America. I expressly said that no blame attached to you.

Prof. FORBES was obliged for the correction. He need hardly say that if he dreamt that such a thing was being done; if he saw now that the Cataract Construction Company were acting in any unfair way, like that, he should cease to be connected with the work. Mr. Ferranti had said, however, that his design was taken from that of Mr. Brown. Mr. Brown said it was the worst possible design that could have been devised. He knew it was simply a ridiculous assertion that the design of the machine could be said to be in any sense like that of Mr. Brown, but he was glad to be able so promptly to bring a quotation from Mr. Brown to show that he did not think so.

The PRESIDENT having made some remarks, the meeting adjourned till January 11th.

Physical Society, November 24th, 1893.

Prof. A. W. RUCKER, F.R.S., president, in the chair.

Col. Maitland, C.B., was elected a member of the society.

Prof. S. P. THOMPSON then occupied the chair whilst the PRESIDENT read a paper ON THE MAGNETIC SHIELDING OF CONCENTRIC SPHERICAL SHELLS.

In this mathematical investigation the author considers cases in which the equipotential surfaces are surfaces of revolution about a line through the centre of the shells, and the permeability (μ) of each shell is constant. Taking the common centre as origin, the potential within any shell is expanded in terms of zonal spherical harmonics, and the ratio of the shielded to the unshielded field determined. The following important result is arrived at, viz., if the permeabilities of the enclosed and external space be the same, then the ratio of the shielded to the unshielded fields are the same *for each harmonic term*, whether the part shielded be external or internal. It is also shown that the shielding effect on external space when a small magnet is placed at the centre of the shell, is the same as the shielding effect on the enclosed space when the shells are placed in a uniform magnetic field. The case of a single shell with a small magnet at the centre is next considered where the permeabilities of the internal and external spaces are taken as unity. Here the shielding depends on the ratio of the outer to the inner radius (a_1/a_0). When the thickness of the shell is $\frac{1}{100}$ of a_1 the ratio of shielded to unshielded field (Ψ/Ψ_0) is $\frac{1}{13}$ when $\mu = 500$, and $\frac{1}{23}$ when $\mu = 1{,}000$. For $\mu = 1{,}000$ increasing the thickness from $a_1/10$ to $a_1/2$ changes the shielding from $\frac{1}{40}$ to $\frac{1}{164}$, thus showing that after the shell is moderately thick further increasing the thickness is not very effective. When the small magnet is displaced from the centre of the shell with its axis along a radius, then the shielding effect of the shell is greater on the side towards which the magnet is moved, and less on the opposite side. Thickening a single shell being inefficient, the effect of using two or three shells separated by air gaps is investigated. Here, as in the case of a single shell, the shielding is improved by adding permeable material either within the inner or without the outer shell. If the inner and outer diameters are given, then, when the difference in these diameters is small, one continuous shell gives the best result. For a larger difference, two shells separated by an air gap are much more efficient than a single one, and filling up the air gap would appreciably diminish the screening effect. When the permeability of the substance is high the best shielding is obtained when the radii of the bounding surfaces of the shells are in geometrical progression. The great value of lamination is shown in the following table, where the volume of the permeable material is expressed in terms of that of the enclosed space, and the shielding in each case being the best.

	Volume of material used.	External field.
Single shell	1·0	0·018
Two shells	5·0	0·0006
Three shells	4·8	0·00016
Single shell	7·0	0·0102

The conditions for the best arrangement in each of the following cases are fully worked out in the paper, viz., two shells, when the largest and smallest radii, and the volume of the material used are given; two contiguous shells of different permeabilities; and three shells of different permeabilities. The main results of the investigation are that with thin shells lamination is useless, whilst with thick shells it is essential, if the best effect is desired. Experiments made on actual shells had fully confirmed the theoretical conclusions.

Prof. MINCHIN said the mathematical results were very simply expressed. Although the work was apparently restricted to zonal spherical harmonics, some of the important formulæ apply equally to general spherical harmonics. Referring to the difficulty of shielding by single thick shells, he pointed out that the equation giving the relation between the shielded and unshielded fields with different thicknesses of shell, represented a hyperbola with its asymptotes parallel to the axes; hence the shielding tended to a definite limit as the thickness increased indefinitely.

Mr. EVERSHED said he had been engaged for the last two years on the subject of magnetic shielding with a view to screening measuring instruments from external fields. In such cases it was not possible to use closed shells, and this introduced trouble. The best results he had yet obtained was to reduce the disturbance to about one-fifth. Another difficulty was introduced by the fact of the shield being magnetised by the current passing through the coil, and owing to hysteresis, the permeability was different according as the magnetisation increased or decreased. By using an outer iron shell a great improvement had been effected. To obtain the best results, it was important to have no joints in the shields. A coil frame with two shields of bent iron was exhibited.

Mr. J. SWINBURNE remarked that the subject divided itself into two: shielding of instruments, and shielding sources. If a dynamo itself be shielded, this did not prevent the currents in the leads producing magnetic disturbances. This was very important in ships. By using an alternator with revolving fields all disturbances could be avoided.

Dr. C. V. BURTON enquired whether, by considering the hydrodynamical analogue of a porous material, the case of perforated shells could be elucidated?

Mr. A. P. TROTTER wished to know if the homogeneity of the shield was of much consequence? At Oxford it had been found that a screen of 4 inches of scrap iron was better than boiler plate.

Mr. BLAKESLEY asked if the effect of moving a magnet sideways in a sphere had been observed. He thought the mathematics developed in the paper would be useful in working out the magnetic theory of the earth.

Prof. S. P. THOMPSON thought that taking the permeability as constant would not be quite correct, for μ was a function of the magnetisation. Hence in the cases considered the outer shell would be the more permeable.

In his reply, the PRESIDENT said, scrap iron in contact was not like clear space, for there were comparatively free paths for the induction at the points of contact. As regards the shielding of the dynamo at Greenwich, Mr. Christie had written to say that the credit was due to the makers of the machine and shields, Messrs. Johnson & Phillips.

Prof. G. M. MINCHIN, M.A., read a paper on the THE ACTION OF ELECTRO-MAGNETIC RADIATION ON FILMS CONTAINING METALLIC POWDERS.

After noticing the resemblance of the phenomena exhibited by tubes containing metallic filings shown by Mr. Croft, on October 27th, to those of photo-electric impulsion cells, he repeated some of the experiments with filings and found the same effects when the filings were of ordinary fineness. He also noticed that the experiments did not succeed either when the filings were coarse or very fine. Coarse ones always conducted, whilst very fine filings or powders acting as insulators, except when strongly compressed. To establish a closer connection with the impulsion cells, he tried films of gelatine and collodion containing metallic powders. Directions for preparing the films are given in the paper. On inserting such a film in circuit with a battery, key, and galvanometer, it acts as an insulator. To render a small portion conducting, the electrodes on the surface of the film are brought very close together, and one of the wires touched with an electrified body (an electric gas-lighter was often used). This caused a current to pass. The electrodes may then be separated a little further, and the process repeated until any desired portion is rendered conducting. The peculiarity of such a film is that if the circuit be broken at the film, the film becomes an insulator; whereas breaking the circuit at any other point leaves the film conducting. The action of the sparks or charges on the conductivity of the films is attributed to the influence of electric surgings produced in the wires by the electric discharges.

The PRESIDENT read a written communication from Prof. O. J. LODGE, in which the writer suggested that the phenomena of the films, and also of Lord Rayleigh's water jet experiments (in which water drops are caused to coalesce by the presence of an electrified body) were due to the range of molecular attraction being increased by electric polarisation.

Mr. BLAKESLEY said he had tried Mr. Croft's experiments and found that conductivity could be established in a tube of filings whilst the circuit was enclosed. Breaking the circuit of a transformer or electro-magnet could produce conductivity; hence he concluded that electric surgings were not essential. Another curious experiment was to put the discharging knobs of an electric machine on a photographic plate at a distance of a few inches. On turning the machine, a small spark travels slowly along the plate from the negative to the positive knob. On reversing the polarity of the machine the spark travels back along the same path, but if the polarity remains unchanged a second spark usually travels along a different path.

Prof. C. V. BOYS asked Prof. Minchin whether the films themselves, or the contacts between the electrode and film, are made conducting by the sparks?

Prof. S. P. THOMPSON wished to know if ordinary photographic dry plates would serve the purpose?

Mr. EVERSHED enquired whether the metal used as electrode made any difference?

Prof. MINCHIN, in his reply, maintained that the phenomena were due to electric impulses. He had not tried photographic plates, and had always used platinum for his electrodes.

DECEMBER 8TH, 1893.

Prof. A. W. RUCKER, M.A., F.R.S., President, in the chair.

Messrs. J. H. Gillett and F. Hovenden were elected members of the Society.

A paper by Mr. JAMES SWINBURNE on A POTENTIOMETER FOR ALTERNATING CURRENTS, was read by Mr. BLAKESLEY.

After referring to the many advantages of the potentiometer method of measurement, the author describes an arrangement by which alternating pressures can be measured. A quadrant electrometer with a double fishtail-shaped needle, suspended by a torsionless fibre, is employed. The electrostatic attraction exerted by an alternating pressure between the needle, and one pair of quadrants, is balanced by the force due to a steady pressure between the needle and the other pair of quadrants. The magnitude of the steady pressure is determined by a potentiometer and standard cell, and the effective value of the alternating pressure thus deduced. For measuring alternating currents, a differential electro-dynamometer having two fixed coils and one moving coil, and no controlling spring, is used. A direct current, measured by the fall of potential over a small resistance, is passed through one of the fixed coils, the alternating current through the other fixed coil, and the moving coil is included in both alternating and direct current circuits. When the two forces balance the currents are taken as equal. Several small inaccuracies to which the method is subject are mentioned in the paper.

Prof. S. P. THOMPSON enquired if the fishtail-shaped needle of the electrometer was novel.

Mr. BLAKESLEY said the author had mentioned the needle previously. He (Mr. Blakesley) thought the name "potentiometer" was not very suitable. In effect, the so-called measurement of *pressures* was a comparison of two *powers*.

The PRESIDENT announced that Mr. Preece's note on the "Specific Resistance of Sea Water," had been temporarily withdrawn.

Prof. G. M. MINCHIN, M.A., made a communication on the CALCULATION OF THE COEFFICIENT OF SELF-INDUCTION OF A CIRCULAR CURRENT OF GIVEN APERTURE AND CROSS-SECTION.

Instead of assuming the cross-section of the wire small and the current density constant over the section as is usually done, the author takes into account the dimensions of the section and the non-uniform distribution of the current. Making use of the expressions for the vector potential (a) of the current given in his previous papers (*Phil. Mag.* April and August, 1893), the author calculates the total normal flux of force through a surface intersected once in the positive direction by every tube of force emanating from the given current. This flux, divided by the current, gives the coefficient of self-induction. The surface chosen is the circular aperture of the current, and half of the anchor ring formed by the wire. When the current density is inversely proportional to the distance from the axis of the circular current, the value for the coefficient of self-induction is found to be

$$\pi\left\{4a(\mathrm{L}-2)+2c\left(\mathrm{L}-\frac{5}{4}\right)-\frac{c^2}{16a}(2\mathrm{L}+19)\right\},$$

where a is the radius of the central filament of the current, c the radius of the cross section of the wire, and $\mathrm{L}=\log_e\frac{8a}{c}$. Clerk-Maxwell's approximate expression agrees with this in the principal term. As an example of the closeness of the approximation, the case of a current in a wire, 2 millimetres diameter, bent to a circle of 2 centimetres mean diameter had been taken, the approximate and corrected coefficients being 58·866, and 59·207 absolute units respectively. When the current in the wire is superficial, as in case of alternating currents of high frequency, the coefficient is somewhat greater, being given by the expression:

$$\pi\left\{4a(\mathrm{L}-2)+2c\left(\mathrm{L}+\frac{3}{2}+\frac{c^2}{16a}(4\mathrm{L}+11)\right\}.\right.$$

Incidentally, it was pointed out that the function G, z, where G is the vector potential at a point distance, x, from the axis of a circular current, was the same as Stokes's *current function* in hydro-dynamics.

Another paper on the MAGNETIC FIELD OF A CURRENT RUNNING IN A CYLINDRICAL COIL, was read by Prof. MINCHIN.

The cylindrical coil is regarded as a series of equal circles lying close together, and forming a cylindrical surface. Replacing each circular current by its equivalent magnetic shell, the problem of finding the magnetic potential at a point resolves itself into calculating the gravitational potential due to two circular plates of attracting matter, one positive and the other negative, situated, respectively, at opposite ends of the cylinder. The magnetic potential due to one plate is then deduced in terms of elliptic integrals of the first, second, and third kinds. The President had pointed out that the expressions given in the printed proof of the paper only applied when the perpendicular from the point to the plate fell within the circle, the author had therefore modified the formula so as to be true generally. From this formula the equi-potential curves can be constructed. The same system of curves serve for the plate at the other end of the cylinder by changing the signs of the numerals representing the potentials, and giving the curves a motion of translation equal to the length of the cylinder in the direction of its axis. The equi-potential curves for the coil can then be deduced by drawing through the points of intersection of the two sets of curves whose numerical values have a constant sum. In determining the curves, the author had to calculate tables of elliptic integrals of the third kind, and these he hoped to complete before the paper was published. In reply to a question on the first paper which had been brought before him by Prof. Perry, the author said that as the diameter of the wire diminished indefinitely, both the self-induction and resistance became infinite, but the ratio L/R became zero. It was interesting to examine what relation between the aperture and cross-section gave minimum impedance. If the ordinary expression for L be taken, the problem was impossible, but the corrected form admitted of a solution.

Prof. PERRY hoped the work Prof. Minchin had done so well for circles and cylinders would be extended to cylindrical coils of rectangular cross-section. It was most important to be able to find the shape of the field produced by such coils.

Prof. S. S. THOMPSON enquired if there was any way of deducing the expression for the magnetic force at a point other than that given in the paper on the "Magnetic Field of a Circular Current" (*Phil. Mag.*, April, 1893).

In reply, Prof. MINCHIN explained how the formula followed at once from the fundamental theorem that the magnetic force is the curl of the vector potential. This was based on Laplace's expression for the force between a magnetic pole and an element of current, which had been proved experimentally.

NEW PATENTS—1893.

23,857. "Apparatus for generating electricity." D. COOK. Dated December 12th.

23,862. "Improved means for the automatic regulation of the position of the brushes of dynamo-electric machines and electromotors." E. H. SOUTH. Dated December 12th.

23,881. "Improved method of and apparatus for heating metals electrically." W. P. THOMPSON. (Communicated by C. L. Coffin, United States.) Dated December 12th. (*Complete.*)

23,883. "Improvements in relays for use with alternating currents, also applicable to vibrators." H. ARON. Dated December 12th.

23,897. "Improvements relating to electric signalling or the transmission of information and energy by electricity and to apparatus therefor." C. J. REED. Dated December 12th. (*Complete.*)

23,902. "Improvements in and relating to electric motors." W. P. HALL. Dated December 12th. (*Complete.*)

23,913. "Improved process and apparatus for dissociating soluble salts by electrolysis." R. HADDAN. (Communicated by H. S. Blackmore, United States.) Dated December 12th. (*Complete.*)

23,914. "Improvements relating to the insulation of submarine and other electric cables." J. A. BISSON. Dated December 12th.

23,951. "Telegraphic apparatus." T. BASSNETT. Dated December 13th.

23,962. "An electric fire-escape." A. C. HEWITT and G. W. PYKE. Dated December 13th.

24,001. "An automatic thermo-electric lubricating apparatus." J. COOMBES. (Communicated by R. N. Coombes, Western Australia.) Dated December 13th.

24,017. "Improvements in or relating to processes and apparatus for obtaining and depositing metals by electrolysis, and in the treatment of the metals after leaving the electrolytic bath." E. STOULS. Dated December 13th.

24,035. "A combined regulating switch, and motor for actuating same." G. COMBE and SIEMENS BROS. & Co., LTD. Dated December 14th.

24,055. "A means of governing or controlling automatically the electric current generated by a dynamo or electric generating machine." J. H. COOPER. Dated December 14th.

24,081. "Improvements in the manufacture of carbon for electric lighting and other electric purposes." R. NIEWERTH. Dated December 14th.

24,104. "Improved combined tidal motor dynamo-electric generator and storage batteries." R. D. RADCLIFFE. Dated December 14th.

24,111. "New or improved means for applying electricity for warming the seats of water-closets, close-stools, and the like." A. D. LAGRELLE. Dated December 15th.

24,131. "Improvements in or appertaining to the electro-deposition of zinc." M. A MOSLEY, R. WRIGHT, and J. H. RICHARDSON. Dated December 15th.

24,152. "Improvements in reflectors and their method of attachment for gas, oil, electric, and other lamps, and like purposes requiring reflectors." E. H. VICARS. Dated December 15th.

24,154. "Improvements in electrical guides or indicators and batteries therefor, specially applicable for carriages and the like." R. L. GRAHAME and E. S. CADMAN. Dated December 15th.

24,217. "Improvements in electrical measuring instruments, and apparatus for use with alternating currents." W. E. AYRTON and T. MATHER. Dated December 16th.

24,234. "Improvements in the manufacture of filaments for incandescent lamps." A. C. COSSOR. Dated December 16th.

24,241. "Improvements in primary batteries." H. WEYMERSCH and E. FREUND. Dated December 16th.

24,243. "An improvement in electrical arc lamps." W. H. LANDER. Dated December 16th.

24,254. "Automatic switch." F. H. NALDER, H. NALDER, C. W. S. CRAWLEY, and A. SOAMES. Dated December 16th.

24,271. "Improvements in and connected with telephonic apparatus." C. BONNARD and F. A. PIAT. Dated December 16th. (*Complete.*)

24,274. "Improvements in apparatus for the electrolytic decomposition of metallic salts." C. KELLNER. Dated December 16th.

24,276. "Improvements in apparatus for electrolytic purposes." H. GUTHRIE. Dated December 16th.

24,285. "Improvements in means for connecting or supporting electroliers, brackets for electric lamps, or the like to or from ceilings, walls, or other places of support." H. EDMUNDS. Dated December 16th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1892.

14,239. "Improvements in electricity meters." G. HOOKHAM. Dated August 6th. Relates to further improvements in the type of meter with immersed armature described in Letters Patent No. 40 of 1891 and 4,064 of 1891, respectively. 6 claims.

16,300. "Improved method of and means for supplying electricity to the carbon electrodes employed in the electrolysis of fused electrolytes." H. H. FREI. Dated September 12th. Has for its object to supply the current to the carbon electrode at a point near to or even below the level of the bath. 2 claims.

16,315. "Improvements relating to electric telegraphs." F. E. W. BOWEN. Dated September 12th. Relates to an electric telegraph by which writing or drawing at the sending station is simultaneously reproduced at the receiving station. 2 claims.

16,335B. "Improvements in magneto-electric generators." E. M. HARRISON. Dated September 13th. Relates to improvements in magneto-electric generators, whereby alternating currents of increased strength are produced, so as to overcome the resistance of the line, thereby producing a clear and sharp ring of the call bell. 2 claims.

16,335C. "Improvements in electric bells for telephones and like purposes." E. M. HARRISON. Dated September 13th. Relates to improvements in electric bells for telephones and like purposes, whereby the construction is simplified, and the bell hammer is strongly actuated by the electric current. 2 claims.

17,091. "Improvements in insulating and supporting electric wires intended to act as resistances, applicable as radiators of heat for cooking, warming and other purposes." R. E. B. CROMPTON and H. J. DOWSING. Dated September 24th. Consists of various methods of coating metallic surfaces with enamel, and afterwards attaching to this enamel electric conductors which are intended to be raised by the passage of electric current to high temperatures, in order that the metallic plates may serve as radiators of heat for electric cooking, electric warming and similar purposes. 2 claims.

17,093. "Improvements in electrostatic measuring instruments." W. E. AYRTON and T. MATHER. Dated September 24th. The improvements consist:—First, in making the terminals of such instruments so that they may be connected with or disconnected from the electric circuit without danger of shock; secondly, in the combination of "safety terminals," as above described, with fuse holders easily removable from the instruments; thirdly, in devices for readily disconnecting all the working parts of such instruments and other conductors connected with them from the terminals, and subsequently bringing those parts to the same potential; fourthly, in arranging the capacities of the parts connected with the mains so that persons touching the outer metal case shall not receive serious shocks when the instrument is used on alternate current circuits; and fifthly, it relates to spark gaps whereby the vital working parts are protected from injury which might be caused by sparks passing between them. 5 claims.

17,099. "An improvement in carbon electrodes." H. T. BARNETT. Dated September 24th. The carbon is in the form of a number of fine short filaments in contact with and outstanding from a suitable carbonaceous or metallic conducting support. 1 claim.

17,877. "Improvements in regulators for dynamo-electric machines." T. R. ANDREWS and T. PREECE. Dated October 7th. The inventors employ the core of a solenoid to operate a plunger within a cup or vessel containing mercury for the purpose of varying the height of the mercury therein, so as to increase or decrease the resistance of the circuit in which the apparatus is placed. The resistance is created in the circuit by a resistance box, rheostat, or its equivalent, placed in series with the circuit, and the wire coils of the resistance box are each connected to a thin metal plate. These plates are placed one above the other, but are each insulated, and they have a concentric hole forming the above-mentioned cup or vessel of mercury, or the upper part of the walls of said vessel are formed by said plates. By this arrangement, when the said plunger is operated by the solenoid, the mercury metallically connects a greater or less number of said plates, and so decreases or increases the resistance. 1 claim.

17,878. "Improvements in the method of and apparatus for starting electric motors." T. R. ANDREWS and T. PREECE. Dated October 7th. Consists in introducing a resistance frame or rheostat, or similar devices, in the circuit of a "series wound" or "compound wound" motor, or in the armature circuit of a "shunt wound" or compound wound motor, whereby the resistance of the circuit is increased; the core of a solenoid is employed, which may be in series with the circuit in which the resistance is placed to automatically switch the resistance out of circuit. A dash pot, or its equivalent, is arranged in connection with the core of the solenoid, so that it is only free to move at a comparatively slow speed when the current is applied. And the parts are so arranged that when the current is cut off the core automatically returns to its original position and again puts the resistance in circuit. 3 claims.

18,357. "Improvements in the construction of electrical switches." S. T. WYAND and LOUIS SCHRAMM. Dated October 13th. The inventors make the base of switch of any suitable material, and so formed as to be a bearing and guide for a contact sliding shoe, and a handle also with a channel for a spring and fixing contact lugs. To the lower portion of the handle they suitably pivot a link, the other end of which is pivoted to the upper portion of a sliding shoe, under the said shoe is placed a suitable spring, over which it rides by means of the action of the handle, so as to make and break contact between the contact lugs when the shoe is moved over its centre of motion. 2 claims.

18,847. "Improvements in field magnets and armatures of alternating current electro-motors, applicable also to the electro-magnets of electric arc lamps and other apparatus." H. F. JOEL. Dated October 21st. The inventor makes the iron field magnet cores and poles of the motor of very thin laminated iron stamping, shaped so as to form the poles and field cores all at one time without any after tooling, and he places any required number of these stampings side by side and insulated the one from the other, and bolted together to form any desired power or size, and to accentuate the effect of the currents in the coils; he interposes some thin plates of steel in some instances. He winds the field magnet cores so formed with two distinct coils of wire on each limb, as follows:—The first layer of one coil is wound from right to left, the next layer being the first layer of the other coil, and wound directly on the top of the first coil, is in the reverse direction to it, that is from left to right, the succeeding or third layer being the second layer of the first coil is wound as the first from right to left, and on this again is wound the second layer of the second coil, or fourth layer of wire from left to right, and so on. 6 claims.

18,966. "Process for the electrolytic decomposition of compounds of metals and sulphur." SIEMENS BROS. & Co., LTD. (Communicated from abroad by Messrs. Siemens & Halske, of Berlin.) Dated October 22nd. Consists essentially in treating natural or artificially produced sulphides, that will form soluble double salts with the alkaline sulphides, with such alkaline sulphides, sulphhydrates, or polysulphurets, to form a solution, and in subjecting the same when in this condition to electrolytic action. 1 claim.

19,242. "Improvements in cases for containing electric batteries and the like." A. OBLASSER and C. THERYO. (Under International Convention.) Dated April 26th. Comprises the application to the interior of the box of a special coating designed to render it absolutely tight, and a translucid cover to enable a person at any moment to observe what takes place in the interior of the box. 1 claim.

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THE ELECTRICAL REVIEW

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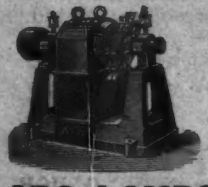

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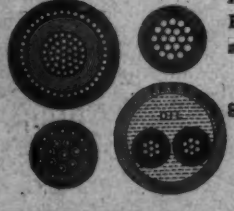

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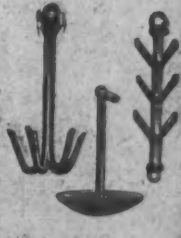

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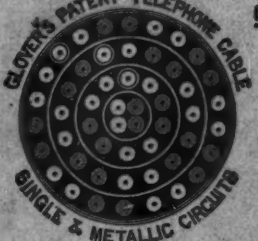

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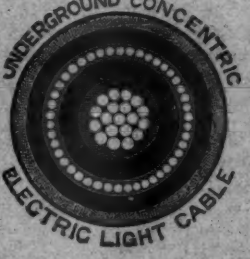

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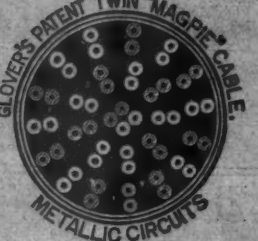

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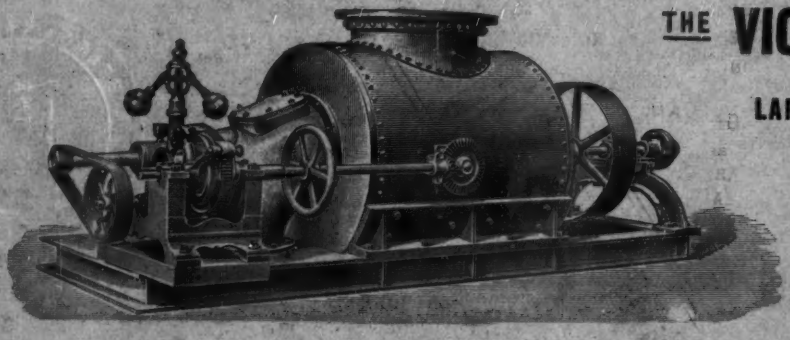

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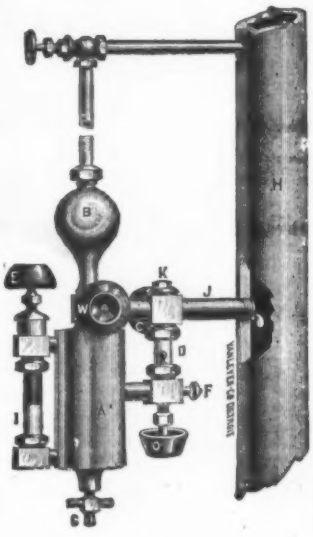

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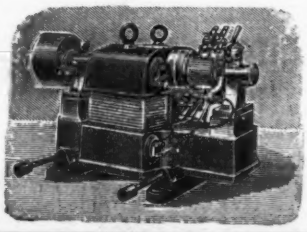

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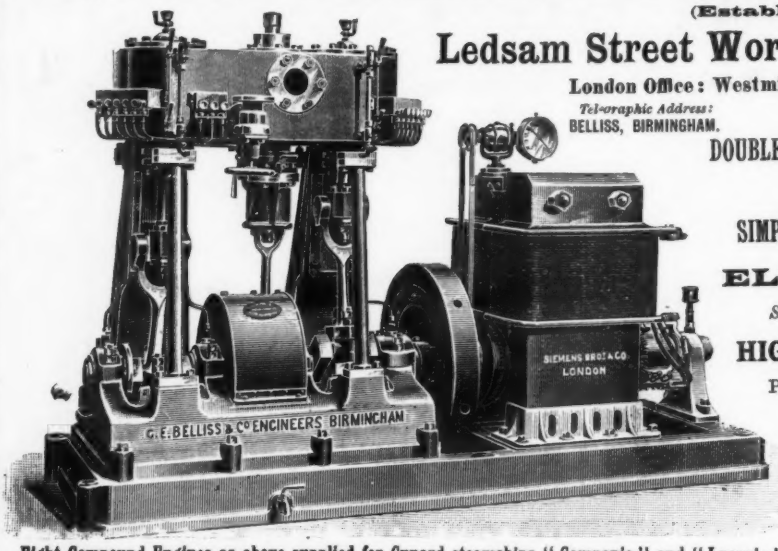

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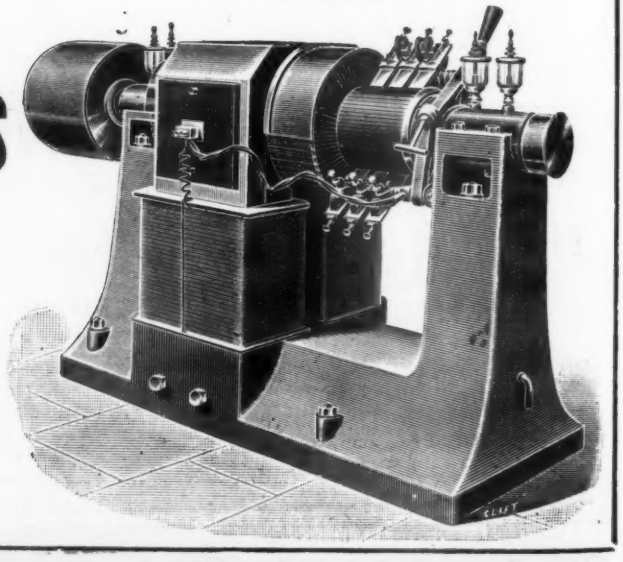

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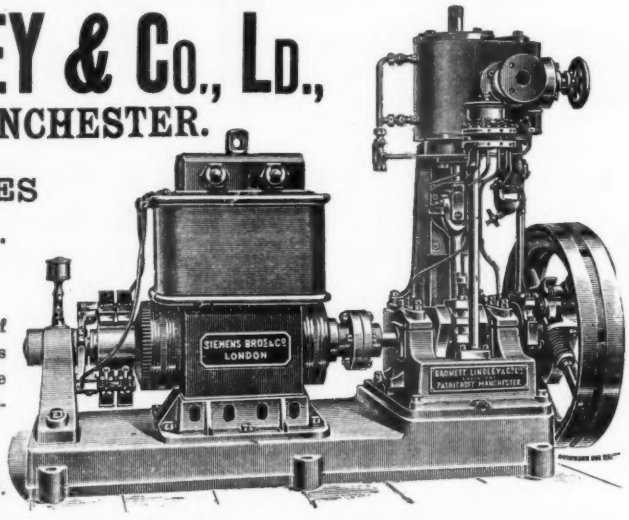

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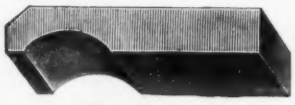

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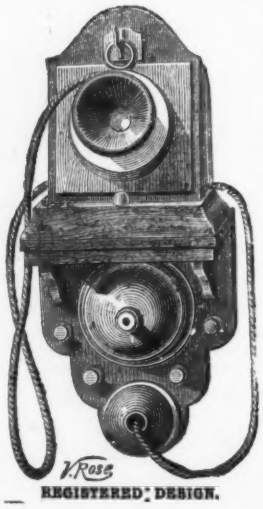

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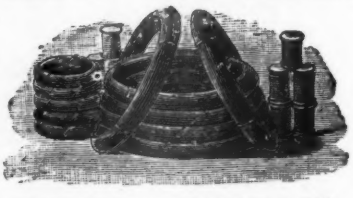

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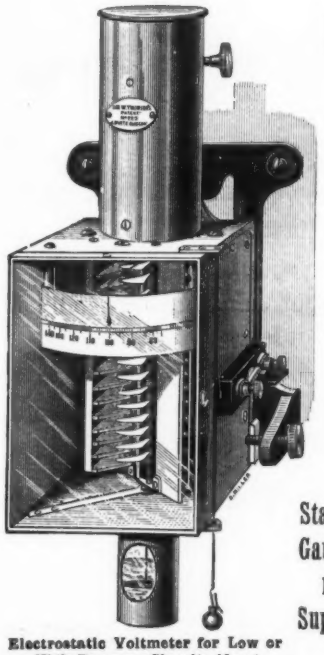

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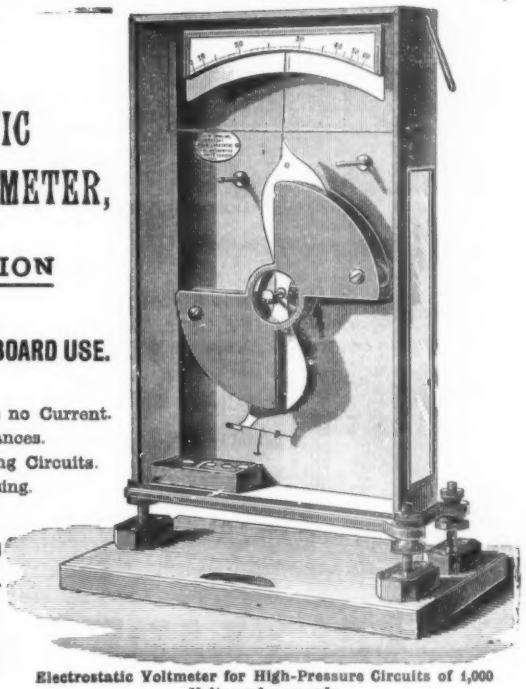

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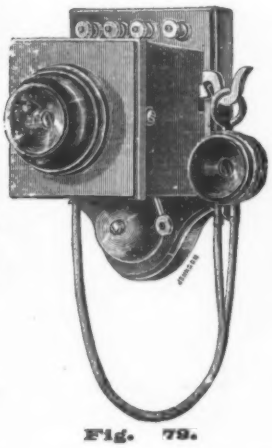

Fig. 79.

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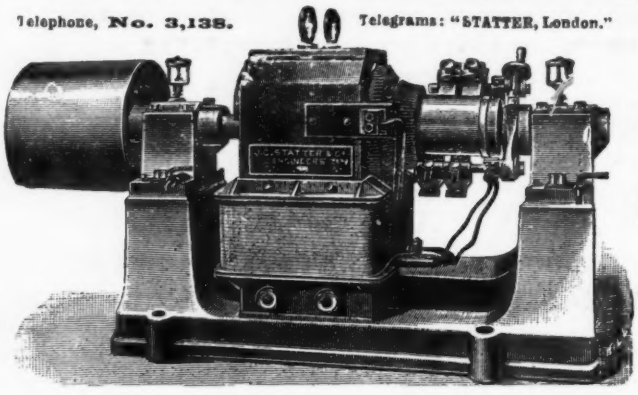

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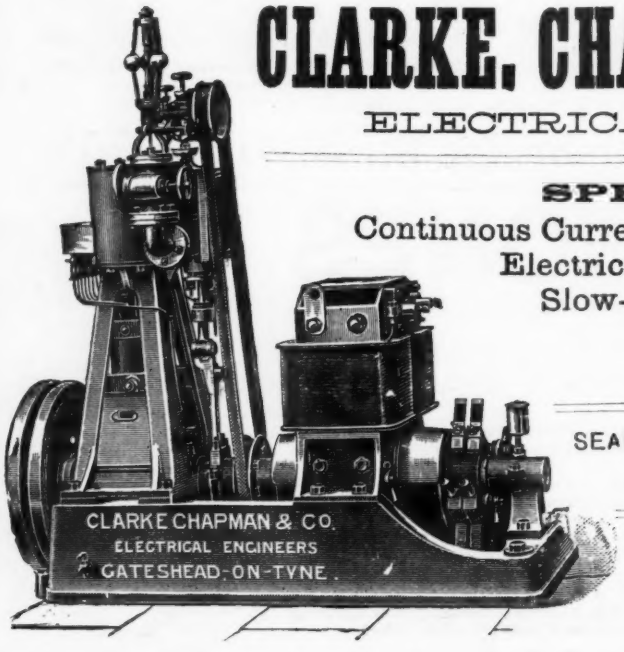

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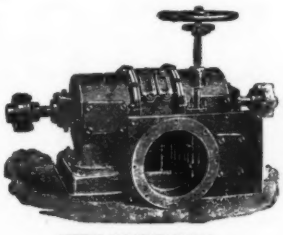

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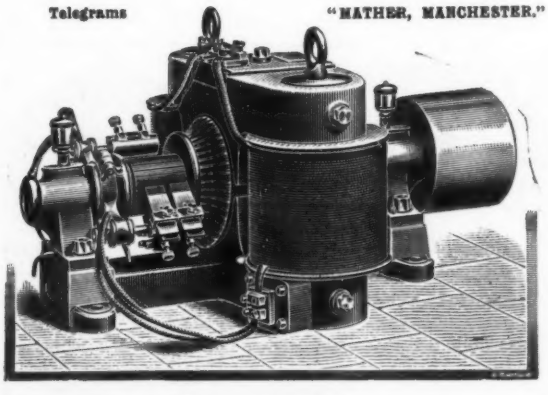

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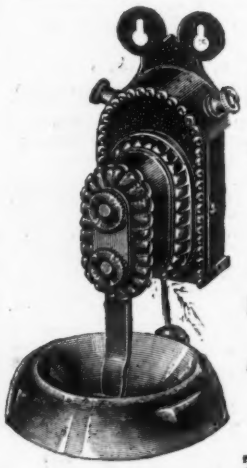

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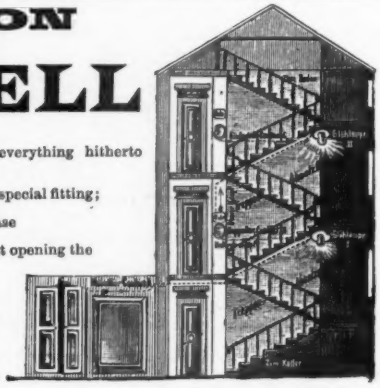

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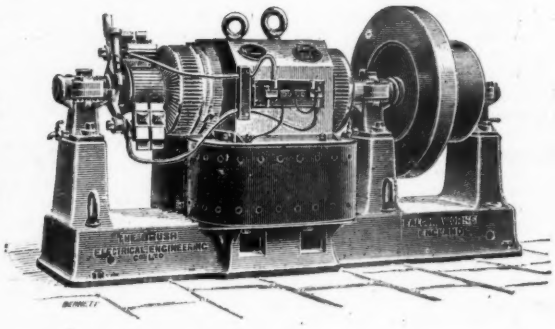

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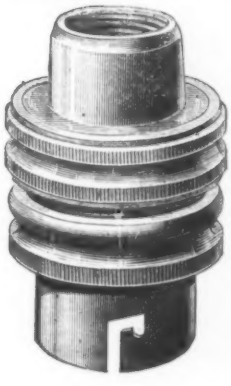

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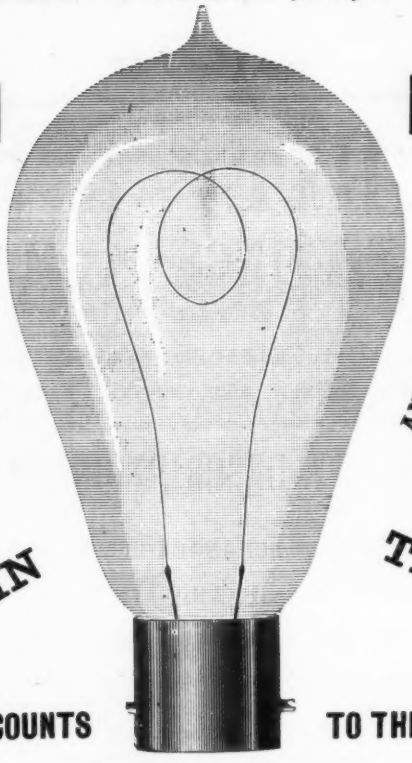

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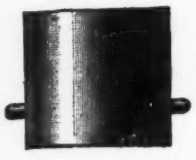

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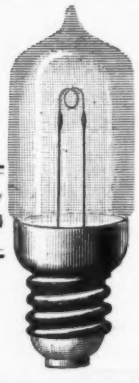

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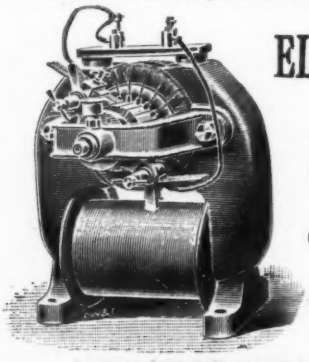

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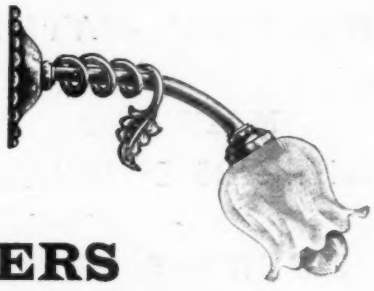

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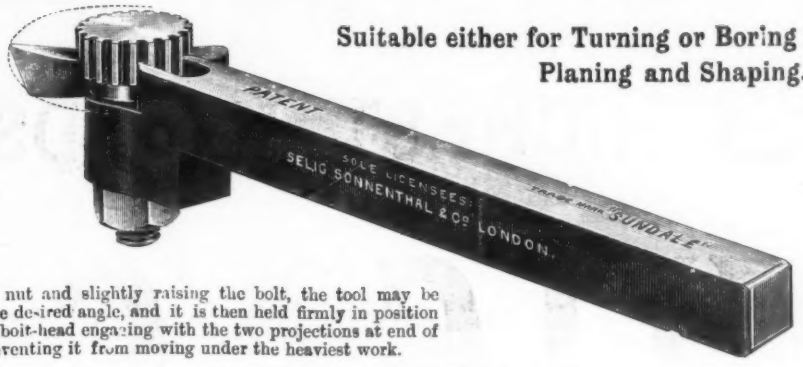

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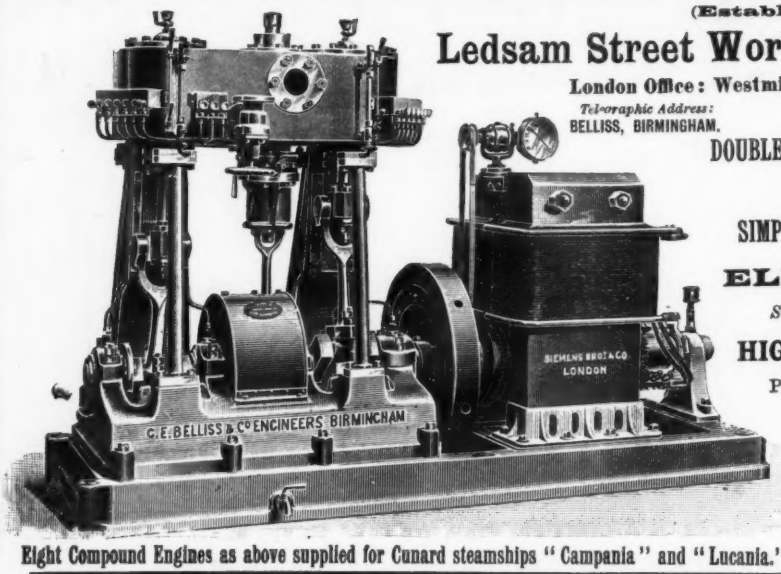

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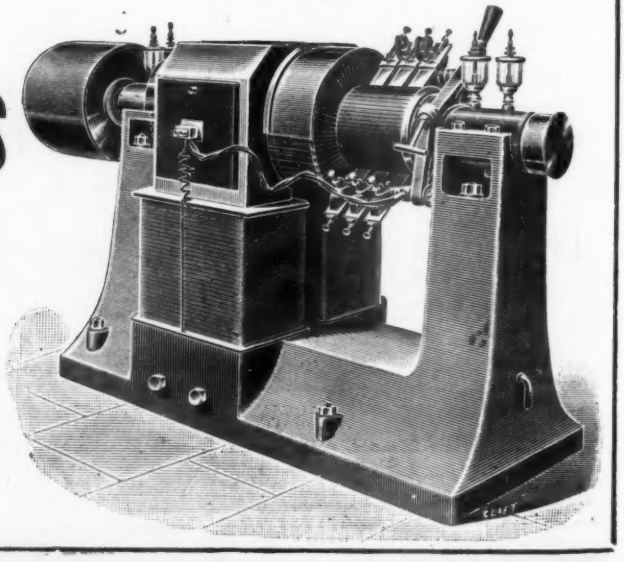

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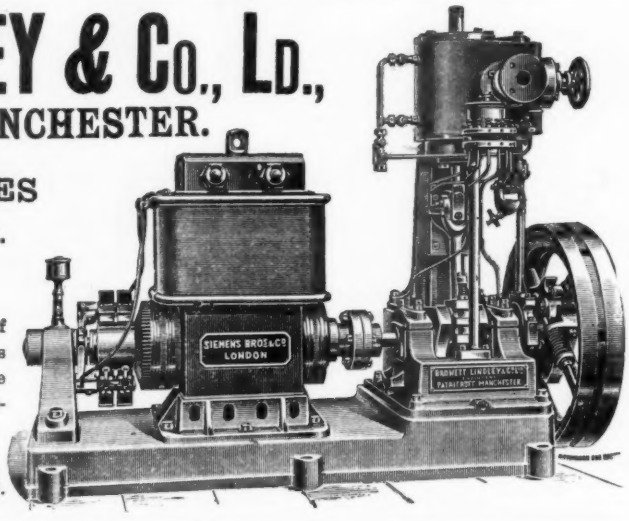

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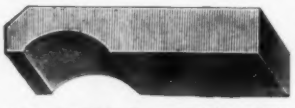

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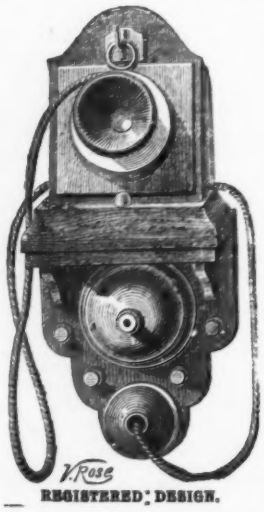

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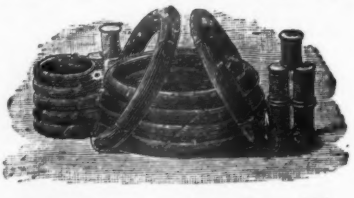

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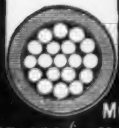

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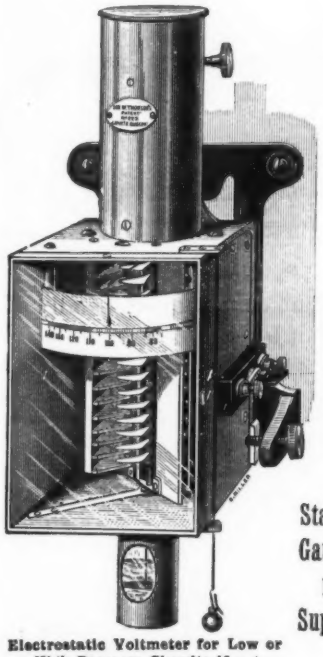

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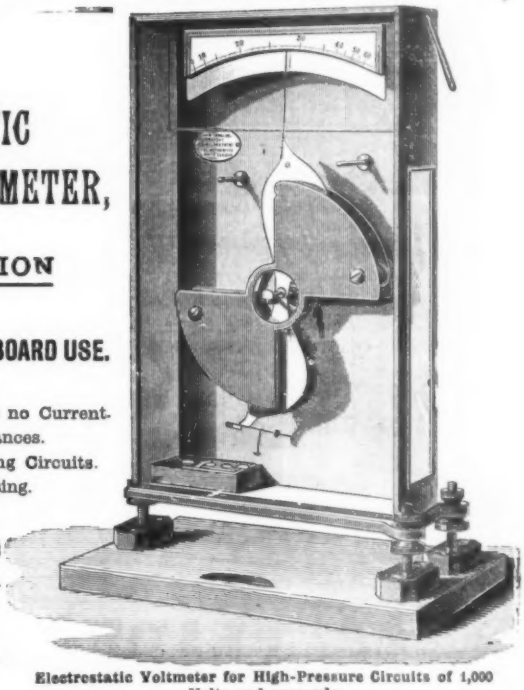

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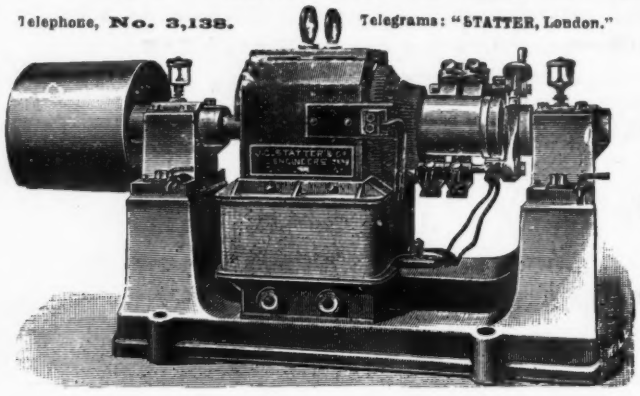

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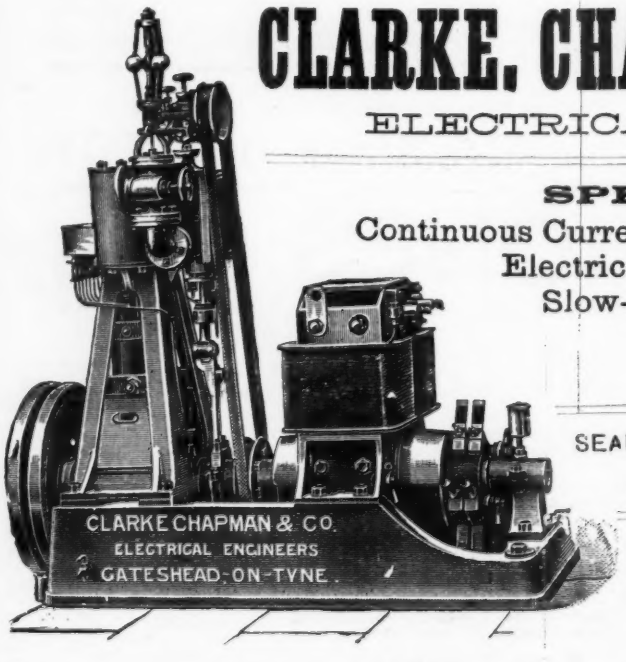

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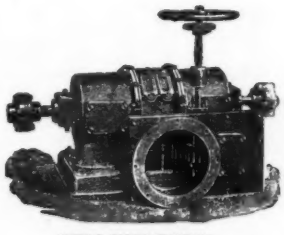

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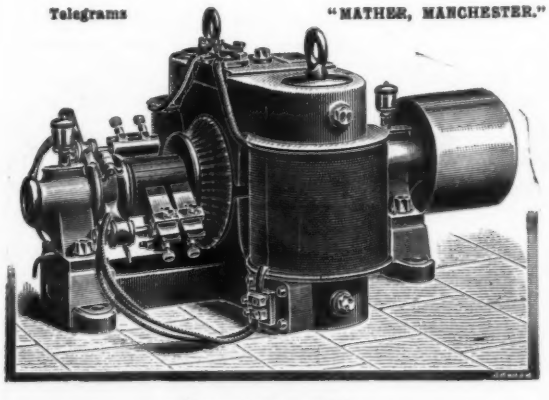

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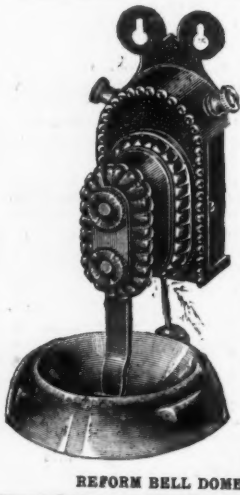

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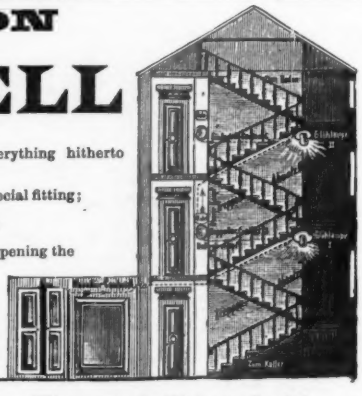

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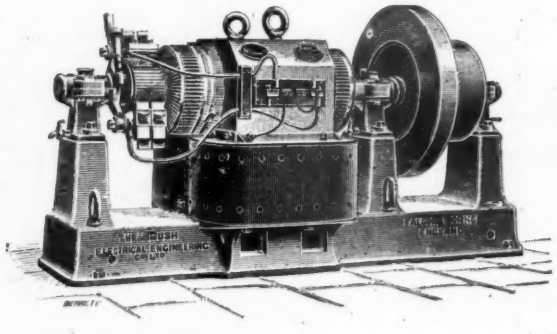

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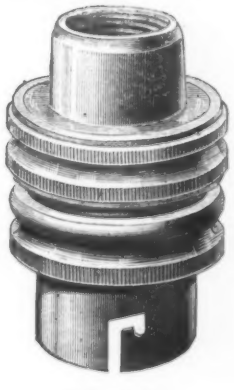

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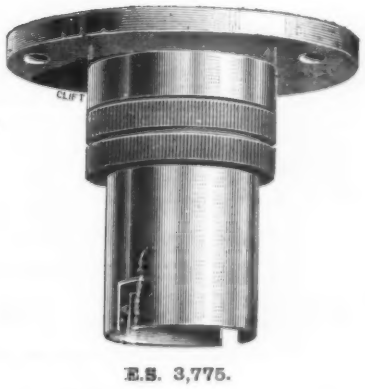

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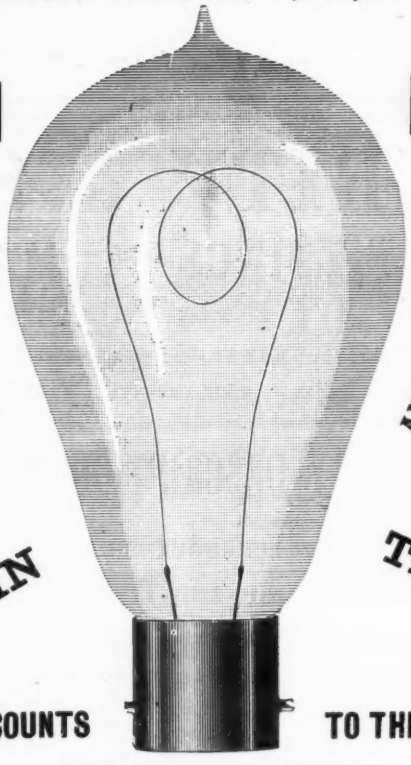

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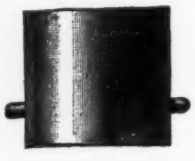

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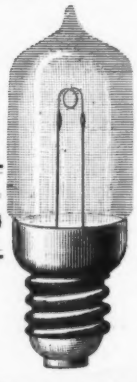

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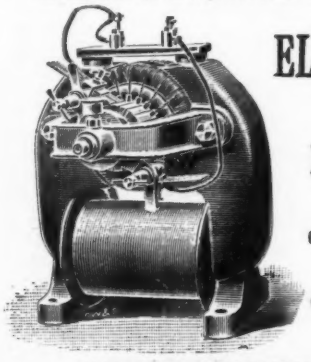

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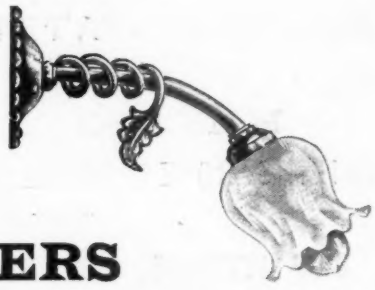

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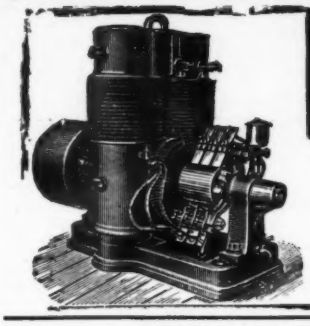

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Particulars of the proposed amendments were set forth in the *Illustrated Official Journal (Patents)*, issued on December 20th, 1893.

Any person or persons may give notice (on Form G) at the Patent Office, 25, Southampton Buildings, London, W.C., of opposition to the amendment within one calendar month from the date of the said journal.

(Signed) H. READER LACK,
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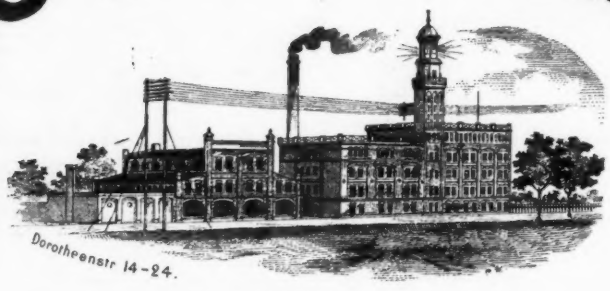

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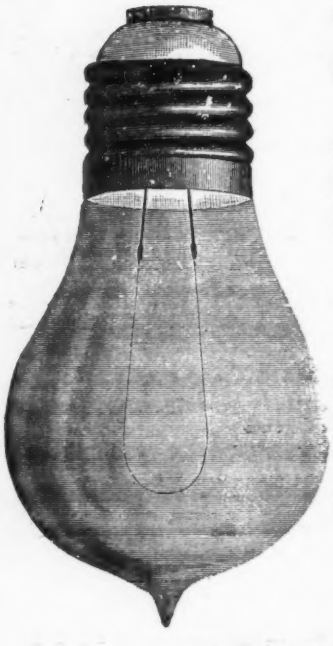

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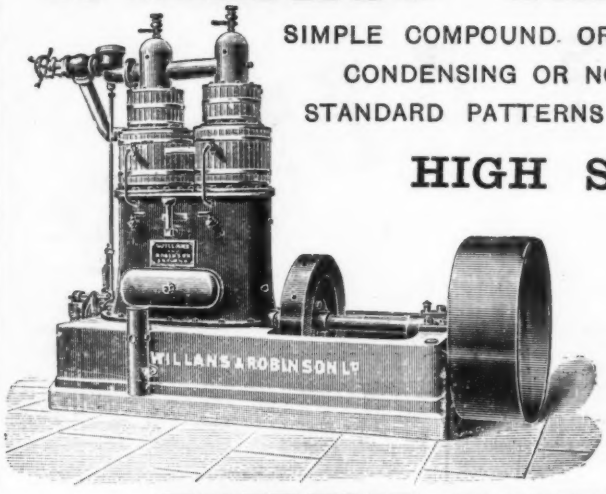

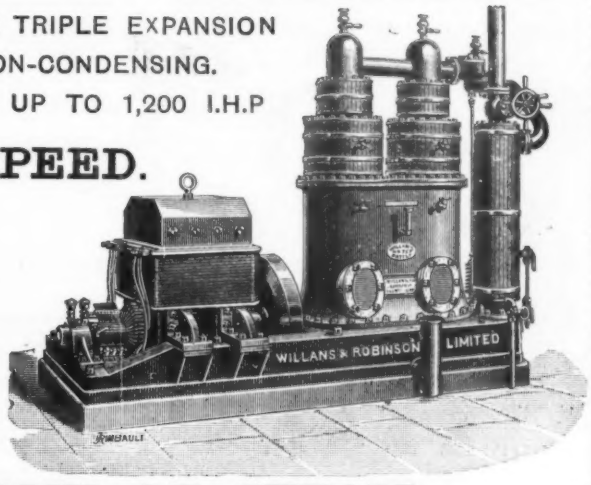

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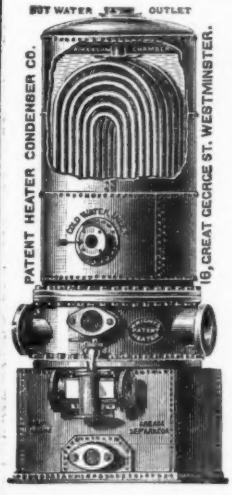

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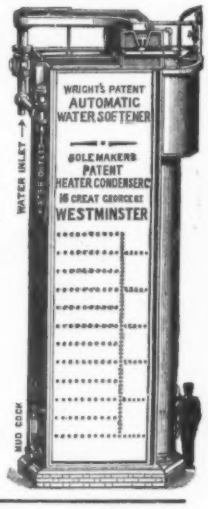

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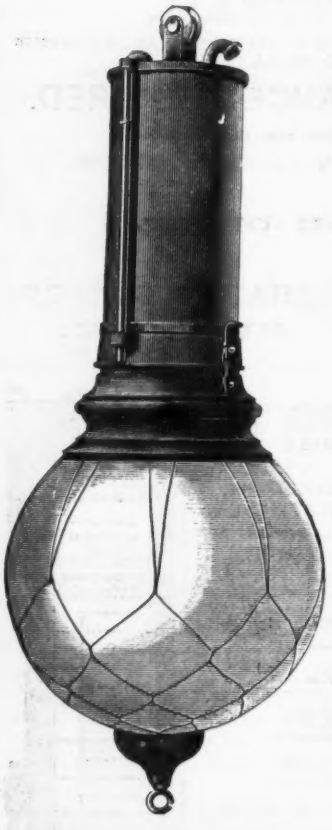

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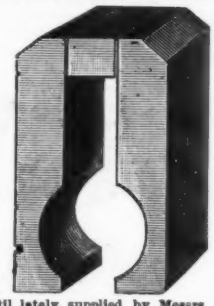

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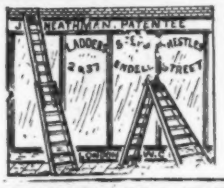

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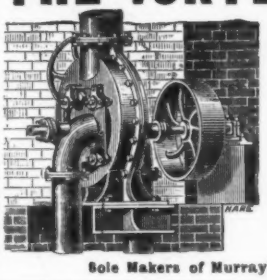

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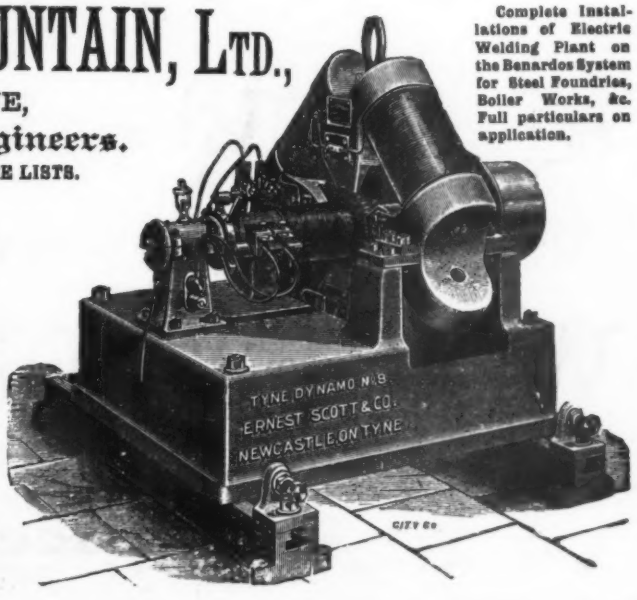

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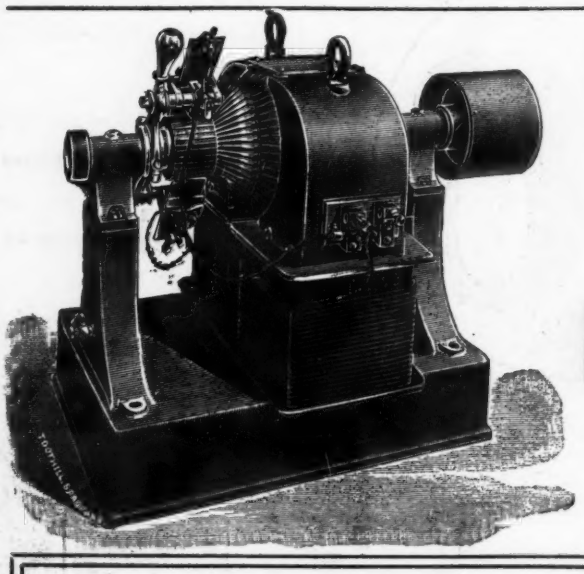

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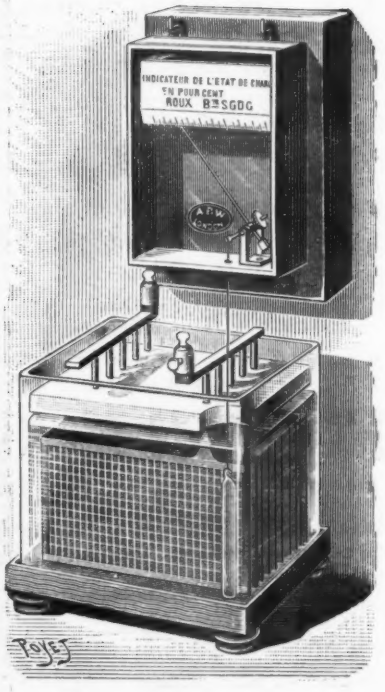

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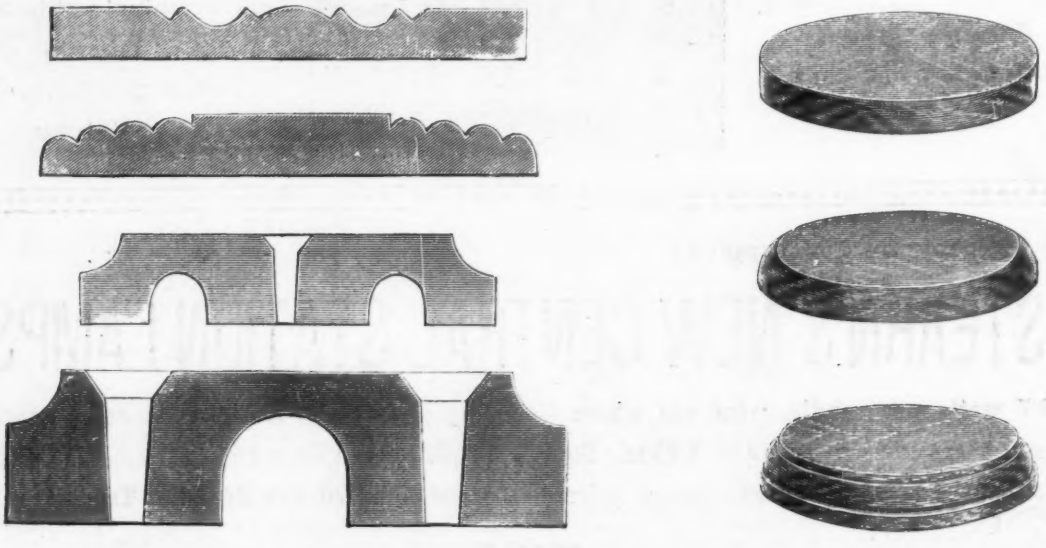

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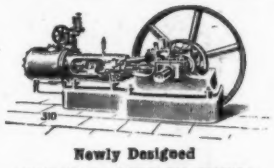

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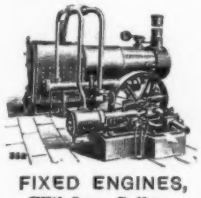

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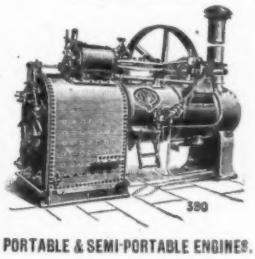

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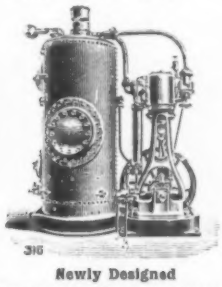

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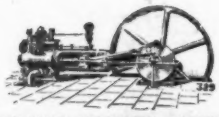

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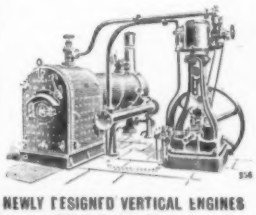

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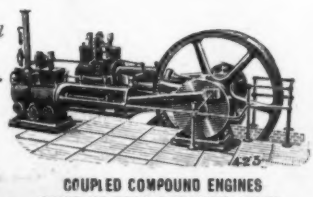

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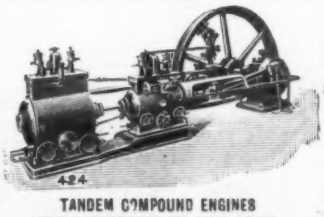

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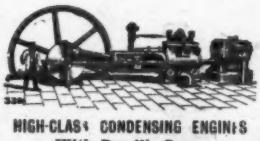

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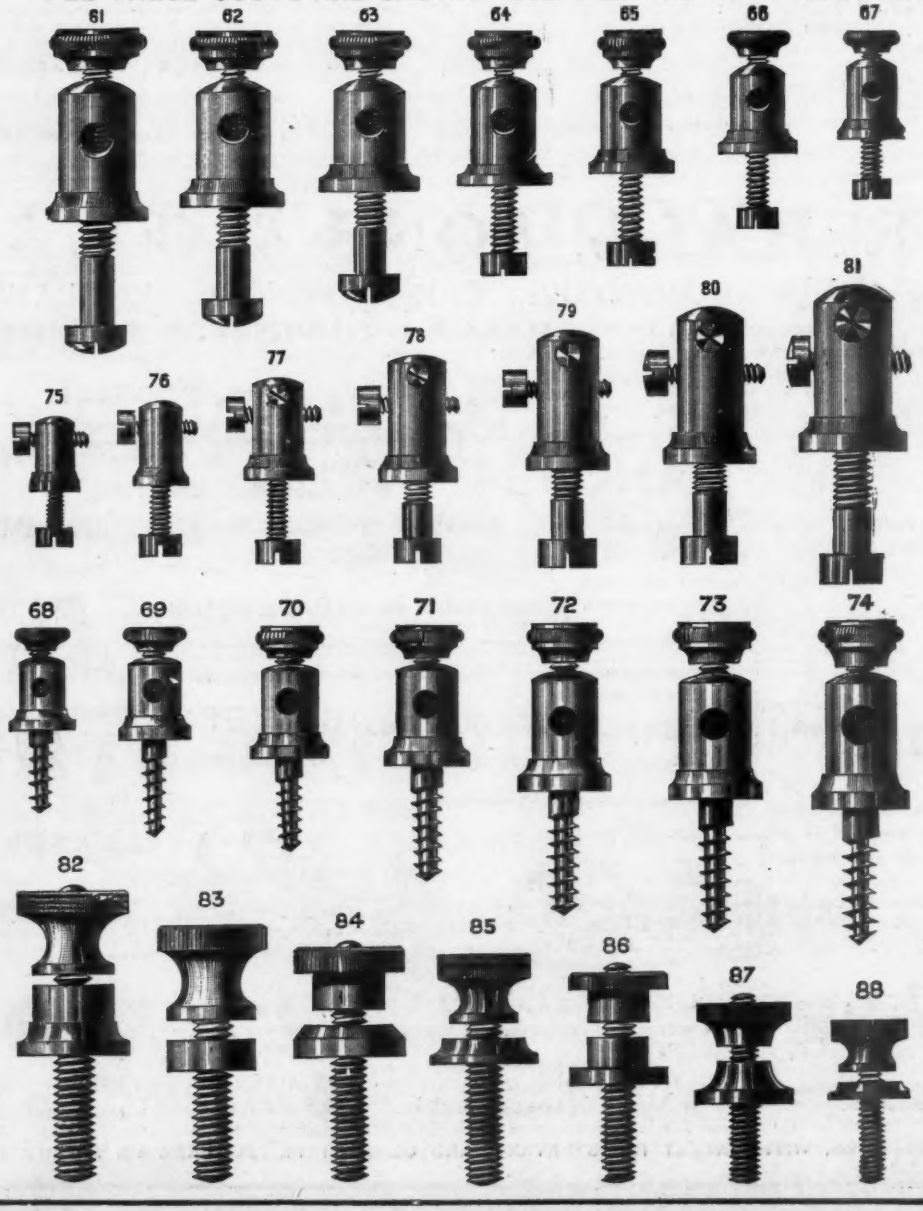

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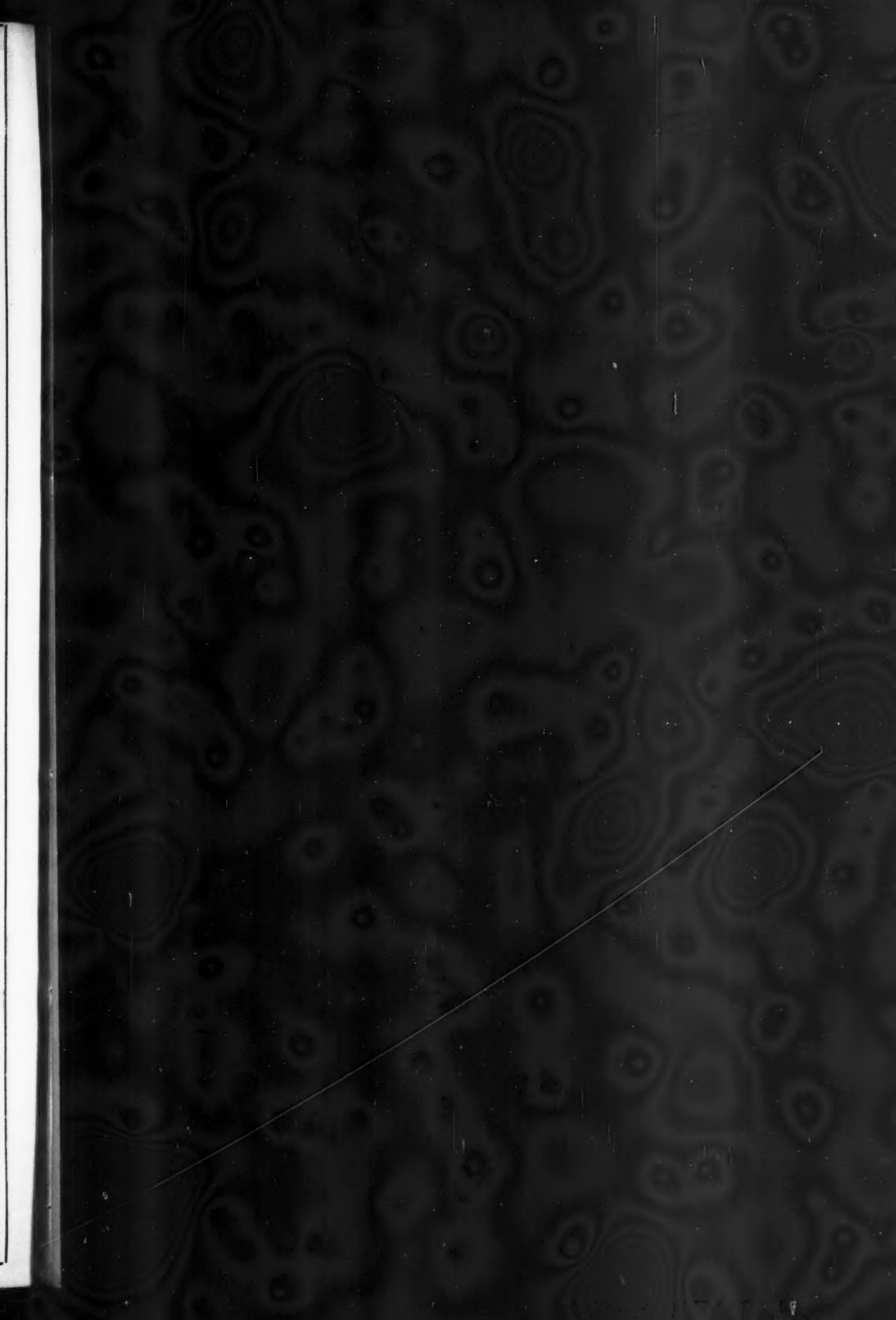

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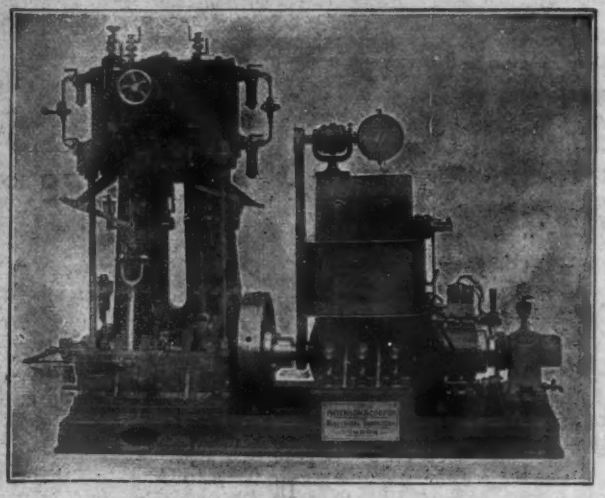

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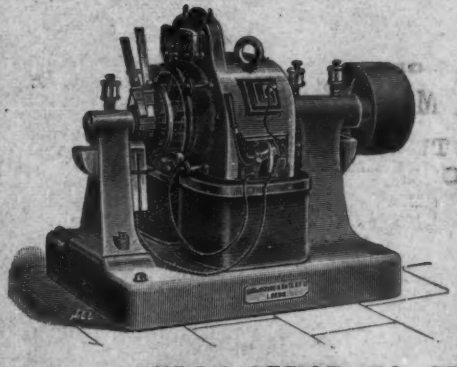

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